POWER

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ELY C. HUTCHINSON, *Editor*

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Thanksgiving

We therefore have great cause of thankfulness—HENRY V

AND it is well that we should stop once in a while and think it over.

Even if thankfulness takes a no more personal form, it is well that our souls should be pervaded with a grateful appreciation of the improved conditions under which we live and of the manifold blessings that as individuals and as a people we are permitted to enjoy.

For the inestimable blessing of a nation at peace our first and heartiest thanks are due. There have been few, if any, wars that justified by their results the miseries they produced. May thirst for empire, glory or commercial advantage, may racial or religious prejudice or national obsession or industrial greed never again be able to provoke one of these catyclisms of wholesale murder.

For health our thanks are also due, individually for those who have been spared affliction, collectively for the progress that civilization has made in the prevention and treatment of disease and extension of the span of useful and enjoyable life.

For means and opportunities. Never in the history of the race has the path to competence and even to opportunity and distinction been wider open to everybody. Never has birth counted for less or money for more. Never has a given amount of human labor been productive of so large a return. Never has the average man had greater leisure and more worth-while things to spend it upon.

There is cause for thankfulness just in being permitted to live in this day and age.

EDITORIALS

For Better Trade Relations

IT IS STILL said that "The laborer is worthy of his hire." But somehow the adage seems effective only in principle in the trade relations between many purchasers and builders.

European builders of power plant machinery and their purchasers have developed it much more generally than have the Americans. Take for example, the matter of efficiency guarantees. European buying practice rarely fails to place a definite cash value upon efficiency when weighing the tenders of competing firms. Usually the tender is credited with half the estimated value, to the purchaser, of each per cent above the acceptable minimum. Other things being equal, the values thus established determine the successful bidder.

Under this system the lowest bidder does not necessarily receive the award and the concern which devotes itself to the production of the best, even at some additional cost, is not penalized for its pains. While this or some similar plan for evaluating bids has been used in a few instances in this country, its more general and even universal adoption should greatly relieve many manufacturers of the competitive restraint which prevents them from always doing their best.

To Discuss Interchange of Power

THIS year's A.S.M.E. annual meeting program will devote a whole session to the closely related subjects of heat and power in industrial plants and the interchange of power between industrials and utilities. Instead of offering new papers on the subject, the time will be devoted to discussion of two excellent World Power Conference papers that were presented at Berlin last June.

The idea is good, for the subject is of wide interest and of vital concern to many engineers and executives. It warrants full and frank discussion, along technical and economic lines, unhampered by commercial considerations or personal relations. Unfortunately, at Berlin, discussion was handicapped by the magnitude of the program, the language and the limited number of American engineers that were privileged to attend. At the annual meeting none of these restrictions will obtain and the plan should be fully justified by results.

Automatic Power Plants

THAT a steam power plant must have attendants is a fact widely accepted by engineers, but is it not possible to operate some, if not most, plants without any attendants? At least many may get along with a single supervisor.

A generation ago one would have been termed impractical for proposing to operate an electrical substation without a man on duty, but safely and control apparatus have been developed to the point where a man in the building may be actually a liability. Likewise, a few years ago a hydro plant, however small, had to be under constant supervision, so engineers believed. Now, hydro plants of considerable size are started, connected into the system, and stopped automatically or through remote control.

It may be objected that a steam plant is another proposition. Of course it is, or it would have long ago been made automatic. But there is no basic reason why many such plants cannot be made to operate safely and economically through instrument control. For that matter, many power plants are almost automatic at present. The same reasoning applies, probably with more force, to oil engine plants, where automatic operation is almost inherent in the machine.

If apartment houses and office buildings, as well as small factories, could eliminate the labor loss, the cost of power would be much lower than at present. Houses are satisfactorily heated automatically. Will this not soon be accomplished for power generation?

The Probability Of Cheaper Power

OWNERS of power plants, and the power machinery builders as well, may feel justly proud of the practical performance of their installations. The best of materials, workmanship and mechanical adequacy, together with sustained high efficiencies, have produced splendid operating records. Yet the presence of these components does not always assure the best operating results when measured in terms of the lowest money cost per power unit.

On one side, there is the expensive high-efficiency plant with its comparatively high amortization charges. On the other, there is the less expensive plant with somewhat reduced efficiency of operation.

Assuming both to be of modern design, the obsolescence factor should be practically the same for both cases. Since it is usual practice to use new plants for primary power and relegate the old ones to peak-load service and part-time operation, amortization should be based upon a load factor which takes into account an obsolescence period that spans the useful life of the plant for primary load service only.

The less expensive plant, from this viewpoint, has the advantage, since its capital charge per unit of power output will be lower. Its effectiveness, then, should be evaluated by its relative efficiency, fuel price, operating expense and installed cost.

While opinions may differ as to the method by which the comparison should be made between the dollar-efficiency of the high-cost, high-efficiency plant, and the one of lesser cost and efficiency, there should be no difference as to the virtue of making cheaper power available to the consumer. This is coming and should be the result of logical rather than political processes.

Electric-Steam Generators In Hydro Developments

ELECTRIC BOILERS have been a major factor in the development of Canadian water power and in Newfoundland alone they have been installed to the extent of approximately one million kilowatts capacity. In view of this it is significant that there are practically no such installations in the United States. True, steam produced by electric boilers with power paid for at normal electric rates can seldom, if ever, compete with steam generated by normally priced coal.

Despite this there are certain definite cases in which the electrically generated steam is economically possible. Such a situation is described elsewhere in this number, where the electrical boiler utilizes excess and otherwise wasted capacity from a hydro plant. The steam it generates is delivered in parallel with fuel-fired boilers to do service in the processing operations of a large paper mill. Additional steam is delivered to process from the exhaust of steam turbine-generators which, in turn, derive their supply from the fuel-fired boilers. Thus the hydro-plant, which has a single transmission line to the paper mill approximately 100 miles, and the fuel-fired steam plant operate together to provide a maximum continuity of service.

In other cases electric steam generators obtaining their power supply from hydro plants are used to furnish large industries with their entire steam requirements. Thus a market for excess hydro power is secured until such time as an industrial market for the electric current may be developed. The use of electric boilers considerably improves power factor and offers opportunity for the utilization of off-peak power with consequent improvement of load factor.

Admittedly the conditions that make the use of electric boilers economically desirable in Canada may not exist in many places throughout the United States. Their increasing use and extended services in Canada nevertheless offer food for thought and possibly their adoption for certain purposes in this country. Power plant executives desiring economical use for excess power may find the subject worth investigating.

Why Waste Wood Refuse?

RECENTLY a lumber mill put in a power plant to supply the steam, electric energy and water required for its operation. The plant was designed to burn the wood refuse from the mill, thus insuring cheap power.

The supply of wood refuse was greatly in excess of that required to produce the steam and power needed in the mill. Because the distance the refuse would have to be transported to a market was too great to make its sale economical, special refuse burners were installed to dispose of the excess.

To waste fuel deliberately in such a manner is deplorable. Interconnection with the utility system would have made it possible to dispose of power in excess of that needed by the mill and so utilize the surplus fuel for useful purposes. The mill would have benefited by additional revenue from the sale of this energy and the utility by a supply of cheap power.

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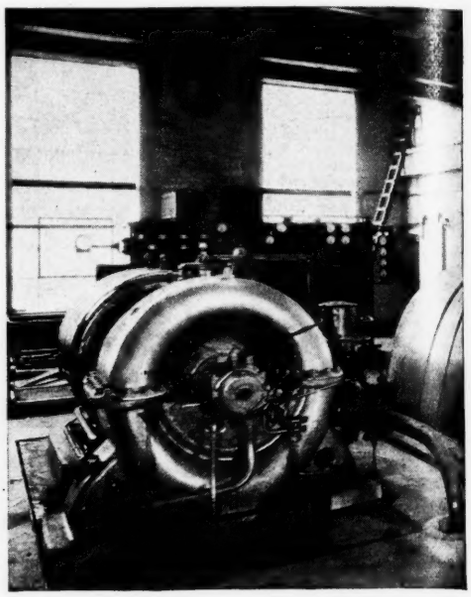
POWER *Stands for . .*

1. **Making Power When It Should Be Made**
2. **Buying Power When It Should Be Bought**
3. **Cheaper Power Through Modern Equipment**
4. **Easier Financing of Equipment Purchases**
5. **Better Use of Byproduct Heat and Power**
6. **Operating Methods That Save Money**
7. **Less Waste in Transmission and Application**
8. **Prevention of Smoke, Within Reason**

STEAM *and* HYDRO *Combined for* POWER *and* PROCESS



A 6,000-kw. steam turbine and 425-lb. boilers for process steam and emergency service insures reliable operation of 570-ton paper mill when hydro power is obtained over a single 110-mile transmission line

AT DALHOUSIE, in Northern New Brunswick, Canada, the New Brunswick International Paper Company is constructing the largest paper plant in the Maritime Provinces. It includes a complete pulp and manufacturing installation to produce 570 tons of newsprint per day. To obtain clear water for the manufacturing processes a concrete dam 100 ft. high was constructed on the Charlo River and the reservoir thus formed was connected to the mill by a 32-in. wood stave pipe line 8 miles long.

The Dalhousie enterprise is typical of the interrelation of water-power development and the paper industry in Canada. The International Paper & Power Company owned the water rights at Grand Falls, on the St. John River, and also controlled large timber stands in Northern New Brunswick. By building the Dalhousie mill a market was provided for the major part of the Grand Falls power that made the development of this project possible. Therefore when the design of the paper mill was being worked out the Grand Falls hydro-electric development was available as the chief power supply.

The hydro-electric development at Grand Falls is owned and operated by a subsidiary, the St. John River Power Company. This plant already has three 20,000-hp. units, operating under a 150-ft. head, and a fourth unit is being installed. The plant is connected with the paper mill by a single 132,000-volt transmission line and supplies a large part of the power for its operation.

A pulp and paper mill requires large quantities of process steam at pressures of about 125 lb. and less. A study showed that this steam could be provided most economically as exhaust from turbines supplied from high-pressure boilers. Installing a power plant at the mill allowed using a single transmission line from Grand Falls to the mill, a distance of 110 miles. The large quantities of steam required for process made an extensive boiler plant necessary. Consequently, the power-generating equipment could be installed at comparatively low cost. The saving in transmission-line cost represented a considerable part of the investment in the steam power plant above that required for a medium-pressure boiler plant. Since the power is produced practically as a byproduct from the process steam, its cost is comparable with hydro.

The single transmission line and a steam plant has a higher degree of reliability than a double transmission line from a hydro plant. By providing sufficient steam-power generating capacity to take care of the equipment necessary to operate the paper machines, practically 100 per cent reliability for this part of the mill is obtained.

Coal comes by rail from mines in Nova Scotia. Provisions are also being made to have it delivered by water. At present it is dumped from cars into a track hopper and delivered either to the crusher hopper or to the storage yard by a belt conveyor. A drag scraper distributes the coal in the storage pile or reclaims it from this pile. After passing through the crusher the coal goes into belt conveyors that deliver it to the bunker. On the belt conveyor an automatic weightometer records the total weight of fuel delivered to the bunker. The bunker is constructed so as to form a series of hoppers that feed through gate mechanisms to the pulverizing mills.

On each boiler there are three ball-type pulverizers, located in the basement below the firing floor and driven by constant-speed squirrel-cage motors. Two of the pulverizers each have a capacity of 5,000 lb. and one 4,000 lb. per hour. They operate at a temperature of

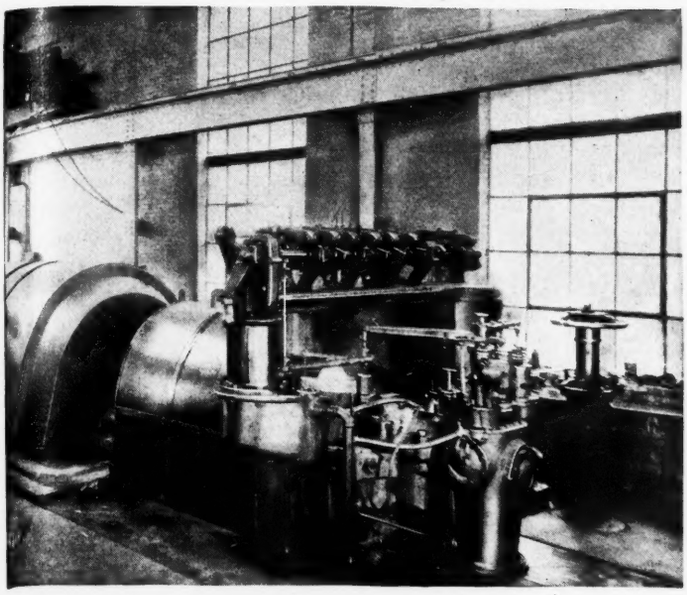


Fig. 1—Process steam at 125 lb. is supplied through a 6,000-kw. turbine

from 200 to 350 deg. F. The figures are based on coal crushed to pass through a ½-in. ring and containing not more than 4½ per cent moisture.

The pulverizer exhausters, on the firing aisle floor, are of the single-discharge, single-inlet type and are driven by wound-rotor motors that give a 50 per cent speed control by secondary-resistance adjustment. Each exhauster discharges to a horizontal-type burner, there being three to each furnace, set on a horizontal line.

The coal feed to the pulverizer is controlled from the firing aisle floor, as is the preheated secondary air, going through the pulverizers and exhausters. The mixture of coal and air goes to the burners at a temperature of about 300 deg. F.

A steam pressure of 425 lb. was selected, and four boilers, each having 13,000 sq.ft. of heating surface, were decided upon. Two have been in operation for about nine months and the other two will be ready for service before the end of the year. They are equipped with superheaters having 3,220 sq.ft. of heating surface, sufficient to give a total steam temperature of 680 deg. at 225 per cent rating. Water walls and slag screens on the boiler furnaces add 800 sq.ft. to the heating surface of each boiler, making a total water-heating surface of 13,800 sq.ft. These walls are on the rear and sides of the furnace and do not have refractory blocks over them. The front walls are of the usual brick construction. Straight-tube air preheaters having 11,910 sq.ft. of surface are installed behind each boiler, with the forced-draft fans immediately above the heaters. There is one forced-draft fan for each boiler, driven by a wound-rotor motor, with its control located in front of the boilers. The control on these motors is arranged for about 50 per cent speed reduction below normal rated value. Baffling is used in the preheaters to give a long air travel, and directly below is a sectional cast-iron soot hopper that discharges into the same trough as the ashpits of the boilers.

The induced-draft fans, of which there are three, are on the operating floor back of the boilers. Gases from each boiler discharge downward through an air preheater, then into a duct from which they are taken by the induced-draft fans, Fig. 3. From the induced-draft fans a duct leads to a brick stack, 200 ft. high x 14 ft. in diameter at the top. Control of the induced draft is by a damper between each boiler and the main duct and by changing the speed of the fans. The fans are driven by wound-rotor motors and are arranged for a 50 per cent speed reduction below maximum. This combination of fans and damper control provides a flexible operating arrangement.

Ashes and soot are removed by sluicing into a trough, back of the boilers, which has hydraulic jet nozzels. The ashes go into a concrete sump, from which they are removed by a clamshell bucket. They are removed once a week only, the job being done in two hours each Sunday by one man with a water hose. Because of the pile of ashes that accumulates in the ashpit during a week's operation, the refractories on the bottom of the furnace cool sufficiently so that they are not injured by the water used in sluicing. In the two boilers now being installed slight changes are being made in the furnace bottoms to facilitate sluicing.

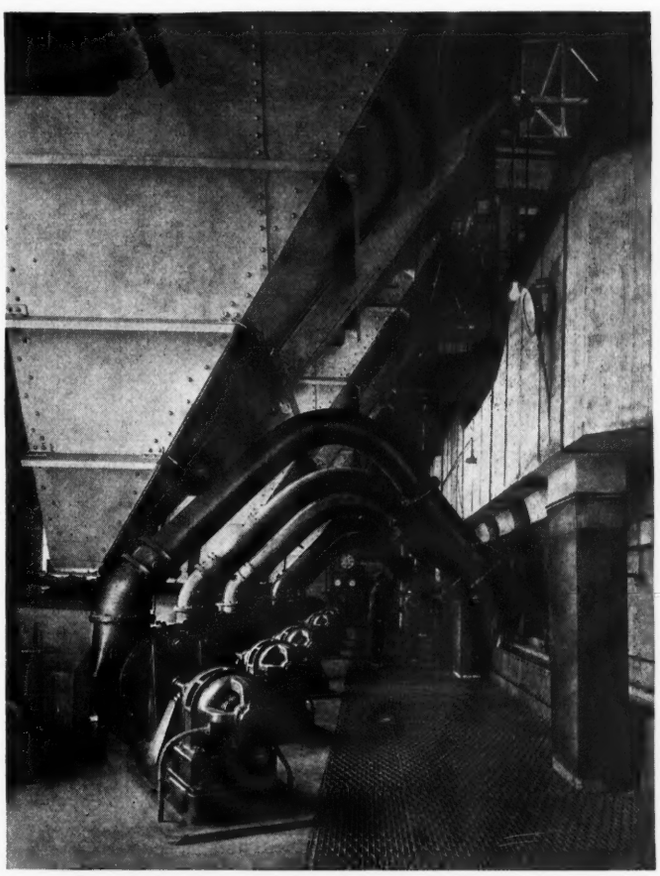


Fig. 2—Pulverized-coal exhausters, on the boiler room operating floor above the pulverizers

Make-up boiler feed water is taken from the pipe line that supplies the mill and is of a fairly good quality, testing about three grains total hardness. All condensate from process and from the heating system are returned to a hotwell, from which it is pumped into the feedwater heater. On account of the nature of the processes a large part of the steam enters the product and is not returned to the hotwell as condensate. For that reason about 35 per cent make-up water is required. Recommendations for treatment of the feed water are made by the Rice Laboratories, the tests being conducted under supervision of the plant chemist.

A pressure of about 5 lb. is maintained in the feed-water heater, from where the water flows by

gravity, at a temperature of 230 deg. F., into the two turbine-driven boiler-feed pumps. The turbines operate on 125 lb. steam from the process main and exhaust into the feed-water heater. The pumps and feed lines are in duplicate to insure that the boiler will get water at all times. Feed-water regulators and differential-pressure regulators control the flow of water to the boilers.

Control of the boilers is concentrated on a panel immediately in front of and between each group of two boilers. On this panel, for each boiler, are a four-point draft gage; a steam-flow air-flow meter with a third pointer for recording the temperature of the gases leaving the boiler; a two-point recorder to give the temperature of the flue gas and of the air leaving the preheater; and three recorders to show the temperature of the air and coal mixture entering the burners. Control for the forced-draft fans is also located in the front of this panel. The speed of the induced-draft fans is controlled at the fans, but the damper regulation is on the panels in front of the boilers.

In addition to the four high-pressure boilers there is a 16,500-kw. electric boiler, having a single tank, with three electrodes connected to the 6,600-volt power lines. This unit supplies steam at 125 lb. to the process main. To control the conductivity of the water in this boiler it operates with a small continuous blowdown. Water is supplied to the boiler by two motor-driven feed pumps from the feed-water heater. This boiler is manually controlled and its output is limited by the amount of power available for steam making.

Steam from the superheaters enters the high-pressure header at 425 lb. and a total temperature of 650 deg. F. The main turbine, rated at 6,000 kw., takes steam from this header and exhausts into the process-steam main against a pressure of 125 lb. gage, as shown in the diagram, Fig. 4. This turbine, fitted with back-pressure and speed-governor control, is normally operated on the back-pressure control, to maintain constant pressure in the process line. High-pressure steam is bypassed around the turbine through a desuperheater and reducing valve. This bypass supplies process steam required above that passing through the turbine. Connected into the exhaust of the main turbine is a 750-kw. unit that operates to a 28-in. vacuum produced by a jet condenser.

The main turbine drives a 7,500-kva., 6,600-volt generator that connects to the continuous power bus. A 935-kva., 550-volt generator is driven by the condensing turbine and connects to the boiler house auxiliary bus, the latter being connected to the continuous load bus through transformers, as in the diagram, Fig. 5.

The 750-kw. turbine operates on the exhaust of the main turbine and normally floats on the line, carrying no load. In the event of transmission line failure, the reverse-current relay opens the switch sectionalizing the electric load, which, in turn, automatically throws the main turbine from pack-pressure control to speed-responsive governor control, and if the remaining electric load is more than the process steam will generate, the 750-kw. turbine immediately picks up the remainder of the load to its capacity. This increases the flow of steam through the main turbine, which, in turn, increases the electric output. The 750-kw. turbine also serves as

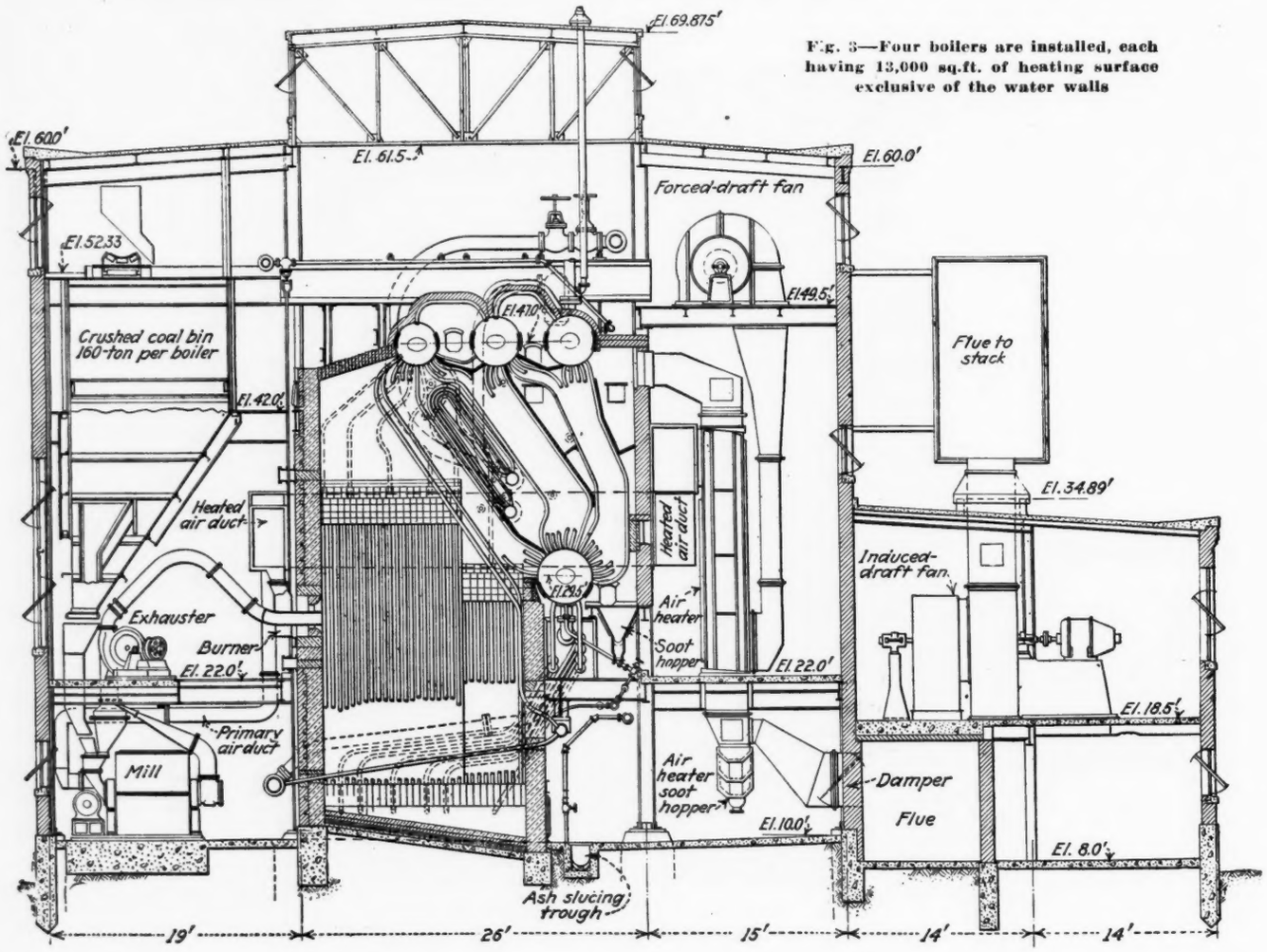


Fig. 3—Four boilers are installed, each having 13,000 sq.ft. of heating surface exclusive of the water walls

Principal Equipment in the Power Plant

General

Plant location, Dalhousie, N. B., at mouth of the Restigouche River
Kind of plant, pulp and paper mill
Capacity, 550 tons of newsprint per day
Designing engineers, A. H. White and R. H. Barber, International Paper and Power Company, New York, N. Y.

Boiler, Superheaters, Air Preheaters and Water Walls

Manufacturers, boilers.....B.-W. & Goldie-McCulloch, Ltd.
Number, 4 Stirling type; heating surface, 12,000 sq.ft.
Pressure, lb. per sq.in. 425
Manufacturer of superheater..B.-W. & Goldie-McCulloch, Ltd.
Type, 4-loop, 3-pass; heating surface 3,220 sq.ft.
Superheat, deg. F., at 225 per cent boiler rating.....200
Manufacturer of water walls..B.-W. & Goldie-McCulloch, Ltd.
Type, plain tube without refractory blocks.
Heating surface, sq.ft.....13,059
Manufacturer of air preheaters, B.-W. & Goldie-McCulloch. Ltd.
Type, straight tube, 11,910 sq.ft. heating surface.
Water columns.....B.-W. & Goldie-McCulloch, Ltd.
Feed-water regulators, type S.C.....Swartwout Co.
Soot blowers .....Diamond Power Specialty Corp.
Blowoff valves .....Consolidated, Ashcroft, Hancock Co.
Safety valves .....Consolidated, Ashcroft, Hancock Co.
Non-return valves .....Edwards Valve & Mfg. Co.
Heat insulation .....Canadian Johns-Manville Co., Ltd.
Walks and gratings.....Irving Iron Works
Feed-water treatment.....Rice Laboratories

Pulverized-Coal Equipment

Manufacturer of pulverizers..B.-W. & Goldie-McCulloch, Ltd.
Number per boiler, 3; type Fuller Bonnot; 2, No. 5 ball mills; 1, No. 4 ball mill.
Capacity, two per boilers 5,000 lb. per hr. and one 4,000.
Drive, gear; No. 5 mills, 50-hp., 1,800-r.p.m., squirrel-cage motors; No. 4 mills 40-hp., 1,800-r.p.m. squirrel-cage Canadian General Electric motors. Control, 6 Manual, reduced-voltage, Allen West & Co., Ltd. and 6 full-voltage magnetic switches, Canadian General Electric Co., Ltd.
Reduction gears.....Hamilton Machine Co., Ltd.
Manufacturer of exhausters..B.-W. & Goldie-McCulloch, Ltd.
Number per boiler.....3
Drive, direct, 15-hp., 1,800-r.p.m. wound-rotor Canadian General Electric motors. Control, manual, to give 50 per cent speed reduction by secondary resistance; 6 Allen West & Co., Ltd. and 6 Canadian General Electric Co., Ltd.
Pulverized-coal burners.....B.-W. & Goldie-McCulloch, Ltd.
Number per boiler 3

Forced-Draft and Induced-Draft Fans

Manufacturer of forced-draft fans.....Sheldon, Ltd.
Type, double-inlet, Keith; 1 per boiler.
Drive, direct, 100-hp., 1,200-r.p.m. wound-rotor Canadian General Electric motor. Control, manual, secondary-sesistance for 50 per cent speed regulation; two Canadian General Electric Co., Ltd. and 2 Allen West & Co., Ltd.
Manufacturer of induced-draft fans.....Sheldon, Ltd.
Number, 3, connected between a duct common to all boilers and the stack breeching.
Drive, direct, 200-hp., 720-r.p.m. wound-rotor, Canadian General Electric motor. Control, manual, secondary-resistance for 50 per cent speed regulation; two Canadian General Electric Co., Ltd., and 1 Allen West & Co., Ltd.

Stacks and Breechings

Stack, brick, constructed by.....H. R. Heinicke, Inc.
Inside diameter 15.5 ft. at bottom, 14 ft. at top.
Height from bottom of furnace, ft.....200
Breechings, construction by..B.-W. & Goldie-McCulloch, Ltd.

Coal- and Ash-Handling Equipment

Coal-handling equipment.....Canadian Mead Morrison, Ltd.
Capacity, tons per hr.....140
Apron conveyor from car hopper to crusher driven by 20-hp., 900-r.p.m., Canadian General Electric squirrel-cage motor. Control, full-voltage, the Rowan Controller Co.
Drag scraper, driven by 75-hp., 900-r.p.m., squirrel-cage Canadian General Electric motor. Control, manual, reduced voltage, Canadian General Electric Co., Ltd. Apron conveyor to crusher, 10-hp., 900-r.p.m., squirrel-cage Canadian General Electric motor. Control, full-voltage magnetic switch, the Rowan Controller Co.
Conveyor from crusher to boiler house, belt, 26-in. wide.
Drive, 25-hp., 900-r.p.m., squirrel-cage, Canadian General Electric motor. Control, full-voltage, magnetic switch, the Rowan Controller Co.
Conveyor over bunker, belt 26 in. wide, driven by 10-hp. 900-r.p.m. squirrel-cage, Canadian General Electric motor. Control, manual, reduced voltage, Canadian G. E. Co., Ltd.
Coal crusher, 140 tons per hour....American Pulverizer Co.
Drive 60-hp., 720-r.p.m., high-torque squirrel-cage, Canadian General Electric motor. Control, full-voltage magnetic switch, the Rowan Controller Co.
Car puller, driven by 15-hp., 900-r.p.m., wound-rotor, Canadian General Electric motor. Control, manual, to give 50 per cent speed regulation, Canadian G. E. Co., Ltd.
Weightometer .....Merrick Scale Mfg. Co.
Ash-conveying system, hydraulic....Allen-Sherman-Hoff Co.
Ash receiver, concrete, capacity, cu.ft.....3,500

Feed-Water Heater

Manufacturer .....Hoppes Mfg. Co.
Type, deaerating; volume, 700 cu.ft.; pressure 1 to 5 lb.
Temperature of water leaving heater, deg. F.....230

Boiler-Feed Pumps

Manufacturer, high-pressure..Canadian Ingersoll Rand, Ltd.
Number, 2; Cameron 4 stage; 700 g.p.m.; 1,213-ft. head.
Drive, 305-hp., turbines.....Terry Steam Turbine Co.

Electric Steam Generator

Manufacturer .....The Dominion Engineering Works
Rating, 16,500 kw., 6,600 volts, 3 phase.
Steam, lb. per hr. 50,000; 135 lb. gage.
Safety valves .....Crane Co.
Control valves .....Jenkins Bros., Ltd.
Control valves .....Lünkenheimer Co.
Blow-off valves .....Everlasting Valve Co.
Shutoff valves .....Edwards Valve & Mfg. Co.
Feed pumps on electric boiler..Canadian Ingersoll-Rand, Ltd.
Number, 2; Cameron 2 stage; 150 g.p.m.; 389 ft. head.
Drive, direct, 40-hp., 1,800-r.p.m., squirrel-cage, Canadian General Electric, motors. Control, full-voltage magnetic switch, the Rowan Controller Co.
Pump governors .....Fisher Governor Co.

Turbine Generators

Manufacturer, main turbine.....General Electric Co.
Number, 1; capacity, 6,000 kw.; speed, 3,600 r.p.m.
Steam conditions, 425 lb. gage, 650 deg. F.
Back pressure, pounds gage.....125
Desuperheater.....Schutte & Koerting Co.
Desuperheater control, type S.C.....Swartwout Co.
Generator, 7,500 kva., 0.80 p.f. 3-phase, 6,600 volts.
Exciter, direct connected, 37 kw., 250 volts.
Condensing turbine .....General Electric Co.
Number, 1; capacity, 750 kw.; speed 3,600 r.p.m.
Steam conditions, 125 lb. gage saturated. Vacuum, 28 in.
Condenser, jet type .....C. H. Wheeler Mfg. Co.
Circulating-pump drive, direct, 30-hp., 1,800-r.p.m. squirrel-cage Canadian General Electric motor. Control, full voltage magnetic switch, the Rowan Controller Co.
Generator, 935 kva., 0.80 p.f., 3 phase, 550 volts.
Exciters, two; 10 kw., 125 volts..Can. General Electric Co., Ltd.
Generator switchboard..Canadian General Electric Co. Ltd.
Oil filters.....DeLaval Separator Co.
Substation switchboard....Canadian Westinghouse Elec. Co.
Storage battery .....Electric Storage Battery Co.
Traveling crane, 20 tons.....Northern Engineering Works

Turbines Driving Paper-Machine Generators

Manufacturer of turbines.....W. H. Allen Sons & Co., Ltd.
Number, 2 installed, 2 being installed.
Capacity, 1,000 hp.; speed 6,500 r.p.m.
Steam conditions, 125 lb. 50 deg. F. superheat.
Back pressure, pounds gage .....5 to 10
Generators, d.c., 540 volts, 900-r.p.m., 600 kw.
Installed by .....Harland Engineering Co. of Canada

Miscellaneous Pumps

Hotwell pumps .....Canadian Ingersoll-Rand, Ltd.
Number, 2 centrifugal, 350 g.p.m., 125-ft. head.
Drive, direct, 10-hp., 1,800-r.p.m., squirrel-cage motors, with full-voltage magnetic-switch control. Can. G. E. Co., Ltd.
Service-water pumps .....Canadian Ingersoll-Rand, Ltd.
Number, 3 centrifugal, 500 g.p.m.
Drive, direct, 150-hp. 1,200-r.p.m., squirrel-cage, Canadian General Electric Co. motor. Control, manual, reduced-voltage, Allen West & Co., Ltd.
Fire pumps .....B.-W. & Goldie-McCulloch, Ltd.
Number, 3, vertical, centrifugal, 2,500 g.p.m.
Drive, direct, 250-hp. 1,200 r.p.m., squirrel-cage, Canadian General Electric Co. motors. Control, manual, reduced voltage, Allen West & Co., Ltd.
Water-storage tank .....Horton Steel Works
Vacuum cleaner.....Allen & Billmyre Co., Inc.
Drive, direct, 10-hp., 3,600-r.p.m., Canadian General Electric, squirrel-cage motor with push-button, full-voltage control.

Valves and Traps

Reducing, high-pressure .....Swartwout Co.
Reducing, low-pressure.....Ruggles Klingemann Mfg. Co.
High-pressure .....Chapman Valve Mfg. Co.
High-pressure .....Edward Valve & Mfg. Co.
Low-pressure .....Jenkins Bros. Ltd.
Atmospheric-relief .....Ruggles-Klingemann Mfg. Co.
Traps, high-pressure.....Strong, Carlisle & Hammond Co.
Traps, low-pressure.....C. E. Squires Co.

Meters and Instruments

Boiler feed water.....Republic Flow Meters Co.
Flow meters, steam.....Republic Flow Meters Co.
Draft gages .....Bailey Meter Co., Ltd.
Flue-gas analyzer .....Hays Corporation
Master pressure gage, Consolidated, Ashcroft, Hancock Co.
Pressure gages, steam, Consolidated, Ashcroft, Hancock Co.
Pressure gage, steam recording.....Foxboro Co.
Recording thermometers .....Foxboro Co.
Steam-flow, air-flow meters.....Bailey Meter Co. Ltd.
Vacuum columns .....Taylor Instrument Companies
Vacuum gages .....Consolidated, Ashcroft, Hancock Co.

Transformer and Oil Switches

Power transformer, six 6,000 kva. 132,000 to 6,600 volts. Canadian General Electric Co., Ltd.
Power transformers, 6,600 to 550 volts; six 500 kva. Canadian General Electric Co., Ltd.; twelve 700 kva., and six 1,550 kva. Moloney Electric Co.
Lighting transformers..Canadian General Electric Co., Ltd.
Oil switches, 132,000 volts, Canadian General Electric Co., Ltd.
Oil switches, 6,600 volts, Can. Westinghouse Electric Co., Ltd.

a house turbine during the time the transmission line is out of service and the mill not in operation.

Each paper machine is supplied with power by a 1,000-hp. geared turbine driving a 540-volt separately excited direct-current generator. The turbines take steam from the process main and operate against a back pressure of about 10 lb., the exhaust going into the paper machine dryers. Any make-up in low-pressure steam for drying is supplied by bypassing the turbine through a reducing valve. An emergency set consisting of a 900-hp., 6,600-volt synchronous motor driving a generator, similar to the turbine-driven units, is provided. This generator can be connected to any one of the paper machines and the turbine can be taken out of service for inspection and repair.

The electric load on the two-machine plant averages around 32,000-kw., including the electric boiler. Power from the Grand Falls hydro plant supplies the major

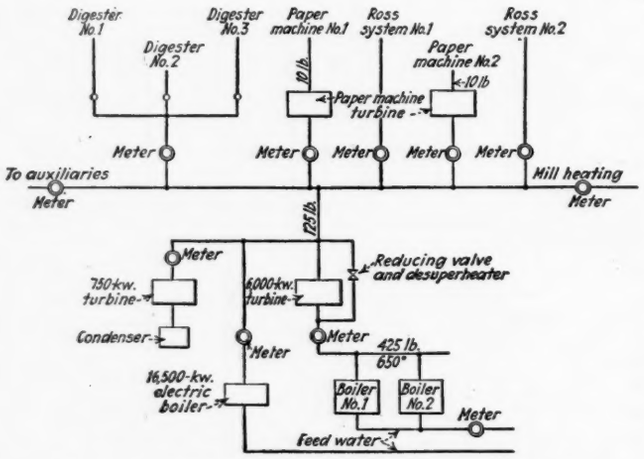


Fig. 4—Simplified diagram of steam equipment and meters

portion of this load. As indicated in the diagram, this power is stepped down from 132,000 volts to 6,600 through two 18,000-kva. transformer banks. The load is divided into what is known as non-continuous and continuous. The former consists of the wood grinder motors and others that can be shut down for a time without interfering with the operation of the paper machines. On the continuous-load bus are the power house auxiliary motors, the motors essential for the operation of the paper machines, and the lighting. The continuous-load bus is connected to the main bus by an oil breaker and also to the turbine-generators. In case of a failure on the transmission line the breaker, between the two bus systems, is opened by reverse-power relays and the continuous load is isolated on the turbine-generators. Pulp storage is being provided so that the paper machine may be operated for four or five hours without operating the grinders.

The general plan of power distribution in the plant is to run 6,600-volt feeders to switch rooms located at load centers. Here the power is stepped down through transformer banks to 550 volts for motors and to a 110-volt, 3-wire system for lighting. From the power transformers the feeders go to switch racks, where the starters are grouped. Open-work construction of the switch rack allows changes to be made readily, and in case of trouble repairs are easily made. The 6,600-volt distribution is by lead-covered cables in underground conduit, and the 550-volt system uses cambric- or rubber-covered conductors installed in rigid-metal conduit.

The grinder motors represent the largest power load. When the plant is completed there will be twelve of them, each rated at 2,400 hp. Of the synchronous type and operating on 6,600 volts, they are started on reduced voltage from a bus supplying 70 per cent normal voltage. The two synchronous motors driving the exciters for the grinder motors are started on 60 per cent taps. The starting of these motors is centered in the main substation switchboard room and is done by the substation operator.

On account of the large synchronous-motor load the power factor is maintained practically at unity.

A feature of the plant is the extensive metering equipment to give a complete check on the use of power and steam in the different departments. Total power delivered to the plant's busbars is metered. All 6,600-volt feeders are metered. When the feeders run to switch rooms and the voltage is tepped down to 550 these feeders are also metered. This arrangement gives a complete check on how the power is used.

Meters are also used extensively on the steam service. In addition to those already mentioned for boiler operation, the turbines and reducing valves, desuperheaters, etc., are equipped with the necessary pressure gages, temperature recorders and other meters for their intelligent operation.

In the chief engineer's office there are meters to show the steam pressures on the different systems; the feed-water heater pressure, the feed-water pressure and the service-water pressure; feed-water temperature; steam flow from the boilers and steam flow to auxiliaries; steam flow to each digester; steam to the mill heating system; steam to the feed water; steam to the 750-kw. turbine; steam from the electric boiler, steam to each of the paper machines and to each of the Ross ventilating systems. Fig. 4 shows the location of some of the flow meters, which give a close check on the steam distribution in the power house and in the mill. When the new addition to the mill is completed more meters will be installed to allow the present complete record of

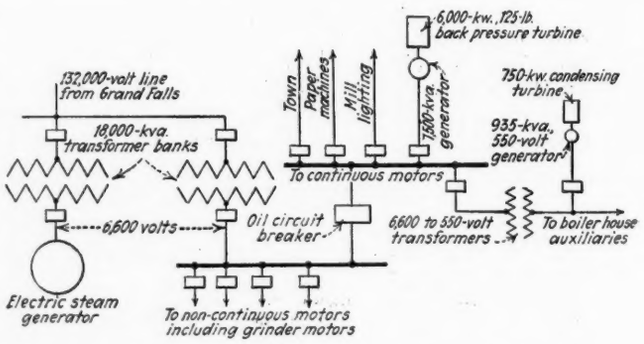


Fig. 5—Simplified diagram of electric power circuits

operation to be maintained. A daily report is made on the basis of the meter readings from which a weekly report is compiled, giving a more complete picture of operation. In addition to the permanent instruments, portable meters and standards are provided to check readings and to calibrate the service meters.

Power wishes to express its appreciation for the assistance rendered in the preparation of this article by G. D. Bearce, general manager; R. G. Edwards, power and steam superintendent; and D. M. Pineo, electric superintendent of the Dalhousie mill.

THE ESSENTIAL PROPERTIES OF A BEARING OIL

By LIEUT. C. A. GRIFFITHS
United States Navy

LUBRICATING OIL has a dual purpose: To prevent metallic contact between moving surfaces and to carry away the heat of friction. That the oil used may fulfill its obligations, it must possess two fundamental characteristics in proper proportion, namely, cohesion and adhesion. Cohesion is that property by reason of which the particles in a mass are attracted to each other; adhesion is that property by which one mass will cling to another. These two properties, combined with still others, form what is generally known as the "body" of the oil. Each property by itself would not necessarily make a substance a good lubricant. Glue has adhesion but will not lubricate, and while clay has a high cohesive attraction, it is not a lubricant.

Internal resistance of an oil is that characteristic which is most important in determining its fitness for the purpose intended. It is a measure of the time the oil takes in seconds for a given amount to flow from a certain sized orifice at a definite temperature, and the unit of measure employed is viscosity. If the oil has a high viscosity it will take a longer time to flow, it will be heavy and sluggish, and difficult to pump. If the viscosity be low, the reverse will be true and the oil will flow freely.

Power plant operating troubles difficult to locate are usually blamed on the lubricating oil. Faults in lubrication being frequently hard to isolate, the lubricant is a catch-all for unsolved riddles, an excellent alibi

An oil of high viscosity will have a greater frictional loss. The relation between the coefficients of friction for oils of different viscosities is shown in Fig. 1, which is based on a large number of oils of all viscosities covered by the range shown. The data were compiled from the results of tests conducted on an endurance testing machine installed at the Naval Experiment Station, Annapolis, Md. On this machine, an oil having a viscosity of 350 sec., Saybolt universal, at 130 deg. F., will have a coefficient of friction of about 0.0052, and another oil of 600 sec. viscosity will have a coefficient of friction of about 0.0058.

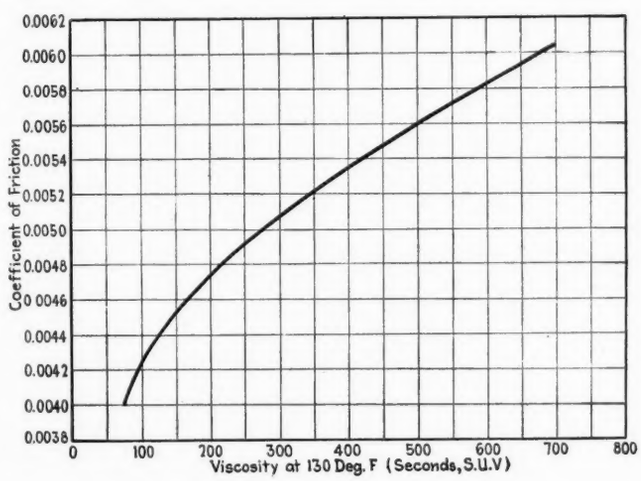


Fig. 1—Variation of coefficient of friction with viscosity

The behavior of a single oil under different bearing pressures in pounds per square inch is shown in Fig. 2. It will be seen from these curves that as the load on the bearing increases, the coefficient of friction decreases. The curve of temperature rise is the difference between the temperature of the oil in the system, without artificial cooling, and the temperature of the atmosphere. This curve naturally increases with an increase in bearing load.

An oil properly selected for a given lubrication job will be such that the cohesion will be strong enough at the highest operating temperatures encountered to prevent rupture of the oil film and consequent metallic contact. Yet the oil must not be so viscous that there is a large loss of power in overcoming the internal resistance of the oil.

By choosing an oil that will have sufficient body to maintain the oil film, the fluid friction will be increased. The obvious result is, therefore, a compromise between a viscous oil that will not rupture and a light oil that will offer the least resistance to flow. The choice must be decided for each piece of machinery lubricated.

If lubrication could be perfected to such an extent that no metallic contact, no matter how minute, would exist, wear would not occur and repairs would be unnecessary. Such a condition is, unfortunately, not the case and, regardless of the care exercised in the lubrication of machinery, repairs eventually follow protracted operation. The greater the attention paid to lubrication, however, the less frequently will repairs be necessary.

When metallic friction occurs the energy lost is converted into heat; when fluid friction occurs the energy is likewise converted into heat, and the temperature of the oil will rise. Consequently, there must be a balance of heat flow between the heat being generated by the moving parts and the heat being removed by cooling.

When the flow of oil to a bearing ceases, trouble in its worst form starts. The recently popularized slogan to

the effect that saving the surface saves all, applies with even greater force to the highly polished bearing surfaces of modern high-speed machinery. No chief engineer can afford to neglect constantly repeated inspections and close examinations of those parts of the lubricating oil system that insure a constant flow of good clean oil.

Dirty oil, oil which has become contaminated through long use or through the introduction of foreign matter water, abrasives, or metal particles, should not be used.

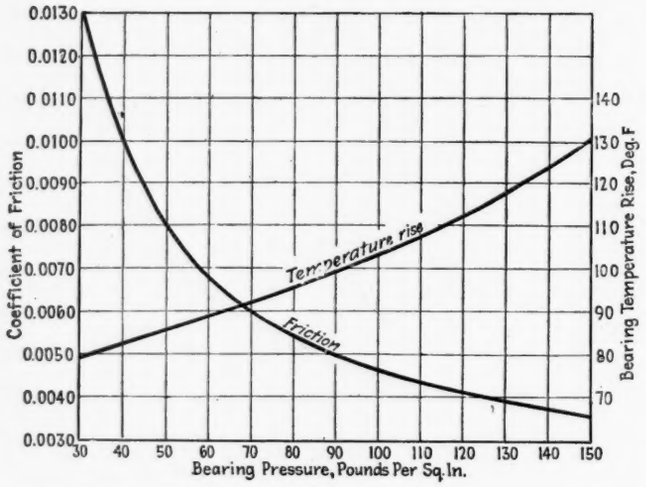


Fig. 2—Influence of bearing pressure upon friction

The oil should be protected by removing these nonlubricating inclusions, and the cost of one of the several oil purifiers now available will be returned in a short time by the saving of oil and through the use of clean oil.

Active corrosion on the highly polished parts of bearings will cause endless trouble. An oil with an acid reaction played on a bearing surface through a forced-feed system will start active corrosion of the metal parts. Corrosion will not only increase the friction that must be overcome, but, if allowed to persist, rust and sediment will accumulate in the oil reservoir and in time may plug the lines. In all natural crudes sulphur is present in varying amounts. When lubricating oil stocks are refined they are also given a treatment with sulphuric acid to purify them. Sulphur from both sources is corrosive, and in a well-refined oil all traces of this corrosive sulphur are removed. Any organic acids must also be removed from the oil during refining. Where refinement is imperfect or cleansing has not been completed, traces of these acids will remain in the oil and will form a nucleus for the increasing quantities of acids which develop in the oil during use under heat and pressure. Lubricating oils should therefore have no sulphur present and should show a neutral reaction.

Of primary importance is the necessity for an oil that will not wear out within a reasonable length of time in use. All oils will oxidize under normal operating temperatures and pressures; some, however, at a more rapid rate than others. The heat and agitation which accompany continuous circulation of an oil in a forced-feed system of a turbine favors more rapid oxidation of the oil, and an oil which resists rapid oxidation is therefore necessary. As it becomes oxidized chemical changes take place in the oil itself; it has a tendency to form sludge; the neutralization number, an indication of the quantity of acids present, increases; and the viscosity increases. All of these effects are interrelated. The more complete the refining, the less will be the rate at which they change. A new oil is naturally a better lubricant than a used oil, and the better a used oil retains its original characteristics the longer will be its useful life.

Every mineral oil has a tendency to form carbon. In use, this carbon-forming propensity of an oil increases, the degree, however, varying with different oils. It is important, particularly in the lubrication of internal-combustion engines, that not only must the initial carbon residue of an oil be small, but the rate of increase in the tendency to form carbon must also be low.

Practically any oil raised to a sufficiently high temperature will completely evaporate. A temperature high enough to cause complete evaporation is seldom encountered in actual service, but evaporation will occur to a lesser degree at the lower service temperatures. Obviously, oil that has been lost by evaporation must be replaced in the system. The most desirable oil therefore is one that, while having the other necessary characteristics, has a low evaporation loss. A small loss by evaporation will require less replacement oil, with a consequent reduction in the oil bill.

When an oil that has served its usefulness is thrown away, it must be replaced with new. An oil that lacks the necessary properties to sustain its life over a sufficiently long period is a loss to the company and poor economy. The obligations placed on modern lubricants are many, but as the design of machinery has advanced so has the quality of lubricants progressed. Oil that possesses a long life, that will not wear out in a short period, can be purchased. And in the long run it pays to get that kind of oil.

Downward Circulation Proposed For Flooded Ammonia Systems

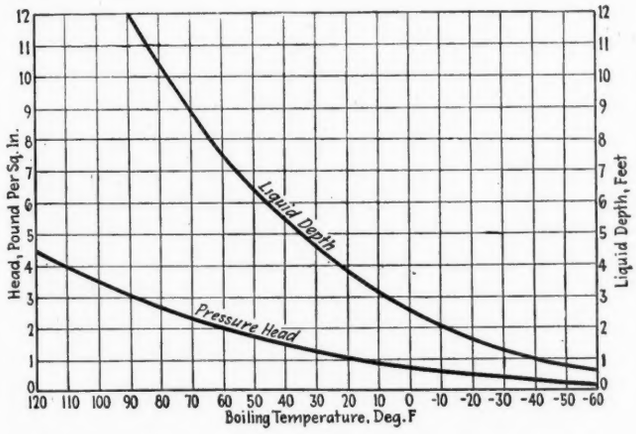
By R. L. SHIPMAN

ONE CONDITION to be reckoned with in any refrigerating evaporating system is the relation between the boiling temperature and the depth of the liquid. This is especially important with liquids boiling at low pressures. The curves shown here give the relation between the boiling temperature and the liquid head and pressure. It can be seen that at 25 deg. F. the boiling temperature is increased one degree for an increase of four feet in depth of the liquid, which causes a pressure increase of little more than one pound. At 50 deg., to increase the boiling temperature one degree, only one foot increase in the depth of liquid is needed. It is obvious that any operating condition that increases the depth or effective pressure of the evaporating liquid raises the boiling temperature and thereby decreases the mean temperature difference between the ammonia and brine temperatures, which decreases the effectiveness of the refrigerating surface at the lower depths. The importance of keeping the pressure as low as possible in the lower part of the coils is apparent.

This brings me to a conclusion that has been in mind for many years: In a flooded system the circulation of the liquid should be from the top down through the coils instead of from the bottom up, as is the usual practice. One time I changed two 25-ton freezing tanks from the direct-expansion system to the flooded system. One of the tanks was finished and placed in service a little while before the other. When I started the second tank I accidently started the liquid circulating down through the

coils instead of upward as they were intended to operate. This condition continued through the first freeze and I could not help noticing that the ice, and especially the tops of the ice cakes, closed up in this tank more quickly than in the other tank, although the latter had worked perfectlty on the flooded system with the circulation of the ammonia from the bottom upward in the coils, as had been intended. I have ever since awaited an opportunity to give that condition a thorough test, but that opportunity has not presented itself. Consequently, I am offerinig the suggestion for what it may be worth, along with designs and directions concerning its principles and applications.

In the first place, at the ordinary temperature and pressures for ice making, the boiling temperature of ammonia liquid will increase one degree for an increase of about $2\frac{1}{2}$ ft. in the depth of the liquid. Since it would require about twice this depth to get effective circulation, the boiling temperature at the bottom of the coil would be about two degrees higher than at the top of the coil, which would reduce the mean difference in


Head, Pound Per Sq. In.
Liquid Depth, Feet
Liquid Depth
Pressure Head
Boiling Temperature, Deg. F
120 110 100 90 80 70 60 50 40 30 20 10 0 -10 -20 -30 -40 -50 -60

Liquid depth in feet head and pounds pressure needed to raise the boiling temperature one degree F.

temperature between the brine and the ammonia in the coil at the bottom by two degrees.

It is true that only a part of this apparent loss would be real, owing to the fact that the liquid returning from the accumulator to the bottom of the coils would be at the temperature corresponding to the pressure in the accumulator and some two degrees below the boiling temperature corresponding to the pressure in the bottom of the coils. But unless the circulation of the liquid through the coils were especially vigorous this advantage would be lost by the temperature of the liquid rising to the boiling temperature corresponding to its depth.

The question naturally arises as to what would be the difference between the wetting effect of the liquid on the evaporating surface, with the two different directions of circulating the ammonia. It is my conviction that for the same suction pressure there would be not only a much better wetting effect with the downward circulation, but there would also be no loss in mean temperature difference, if the system were correctly designed and operated.

Let us subject these conditions to a little analysis. When the circulation of the liquid is upward, some vapor appears with the liquid in the different pipe levels, the ratio of vapor to liquid rapidly increasing toward the higher levels. As this mixture of liquid and vapor comes to a return bend, the liquid piles up at the bend and keeps separating and flowing back against the vapor, which is exerting a pressure against it. Finally, so much liquid accumulates at this point that the vapor cannot pass until it forces a quantity of the liquid up through the return bend. This condition is repeated at each return bend, the elevation retarding the passage of the liquid and the liquid retarding the passage of the vapor, all of which reduces the amount of liquid that can be passing the coil for a given expenditure of energy. If the liquid would stay back in the level stretches of the coils and allow the vapor to pass freely, the upward circulation method might be considered more favorably. But this is not the case. The liquid is forced along by the flow of the vapor in these level stretches, only to pile up and offer resistance at the return bends.

Oil Offers Resistance

Not only do these bad conditions exist, but in practically all designs oil must be contended with. Oil will also impose its sluggish sticky mass at these return bends and present a condition much worse than that of getting the liquid ammonia through the bends. It will partly choke the bends and impose an added resistance to the passage of the ammonia liquid and vapor. It is almost safe to say there is no complete remedy when the circulation is upward, because oil will float on the surface and in the body of the liquid ammonia and cannot be completely trapped out, once it gets to the expansion valve, until it has made its way into the coils. Only positive trapping and separating of the oil from the ammonia before it gets to the expansion valve can cure this trouble.

In the case of downward circulation through the coils, practically all of these ill effects are automatically corrected. The liquid at the return bends not only offers no resistance to passage, but it actually has some syphoning effect on the vapor and liquid in the horizontal stretches. Any oil that happens to enter the coils will have a tendency to move on and will soon find its way to the lowest point, where it can be trapped out.

Now what is going to happen when this mixture of liquid and vapor reaches the lowest point in the system and must begin to make its way back upward to the accumulator? It must be remembered that by the time this point is reached the cross-section of the conductor not only is large, but the conductor is comparatively short, and the resistance to passage is only that of the weight of the liquid ammonia to be elevated to the accumulator.

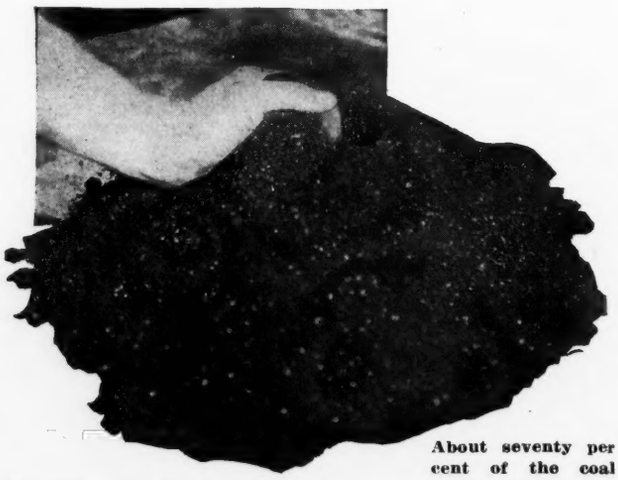
Let us assume that the height through which it is necessary to raise the liquid is six feet, and that the surplus passing is ten times the amount that is evaporated in the coils. For 100 tons of refrigeration this surplus would amount to about 400 lb. per minute.

Just how far it may be advisable to carry this flushing action can only be determined by some well-designed and well-directed experimental investigations.

I suggest circulating the liquid from the top downward in the flooded system. This is not a new idea concerning the circulation of ammonia liquid; it is a question that was debated among refrigerating engineers when we knew nothing but the direct-expansion method of operating coils. In circulating from the top downward in the flooded system it will be well to provide an accumulator large enough to hold the entire charge of the liquid in the coils.

Crushed Coal Burned In Suspension

at Waterbury Clock Plant



About seventy per cent of the coal particles (by weight) are larger than 1/30 inch

Vertical jet furnace burns all fuels tried with equally high efficiency and yields yearly saving of $7,000 in fuel. Coal preparation costs 1.3c. per ton

OPERATING RESULTS of unusual economic interest have been obtained from a vertical-jet, crushed-coal furnace recently installed in the boiler plant of the Waterbury Clock Company, Waterbury, Conn. This furnace, fed directly with coal crushed to pass through a quarter-inch screen, has been in operation for four months. Results obtained to date indicate a yearly fuel saving in excess of $7,000 in a plant whose normal coal consumption before the change was only 4,000 to 4,500 tons per year. Over-all monthly efficiencies on loads ranging from 150 per cent boiler rating in the daytime to 25 per cent at night have been increased from 68 to 78 per cent.

The plant load has so far not required operation at ratings above 150 per cent, but experience with similar installations elsewhere indicates that ratings of 250 per cent can be carried without difficulty and with equally good efficiency when required. Flue temperatures average 430 deg. at rating.

At 100 per cent rating boiler and furnace efficiencies between 81 and 82 per cent (boiler and furnace only) have been obtained for all fuels tried and all have been handled with equal facility.

No trouble has been experienced from the nesting of ash between boiler tubes, nor has fly ash in perceptible quantities been found in the stack gases. No slag of any consequence has formed on side walls.

Before describing in detail the present installation and the results obtained it will be of interest to review briefly the conditions that preceded it.

The Waterbury Clock Company's boiler plant was originally equipped with two old stoker-fired inclined water-tube boilers having 5,000 sq.ft. of heating surface each. Stoker and furnace maintenance costs had become excessive. Average monthly efficiencies (boiler, furnace and economizer) were around 68 per cent. Moreover, it was necessary to use low-volatile high-priced coals to maintain operation.

In 1929 and the early part of 1930 the possibilities for reducing fuel and maintenance costs substantially by the modernization of the fuel-burning equipment were investigated. After studying the performance of available equipment F. W. Carter, plant engineer of the Waterbury Clock Company, recommended the installation of a vertical-jet furnace under one boiler. Work was started in March, 1930, and the unit put on the line in June. Since then it has operated without interruption.

The changeover required removal of the front and side walls of the old furance, excavation to a depth of seven feet to gain additional volume and the building of a furnace with inverted pyramid bottom specifically designed for the selected method of firing and the desired fuel-burning capacity. Revamping of a second boiler setting has recently been completed.

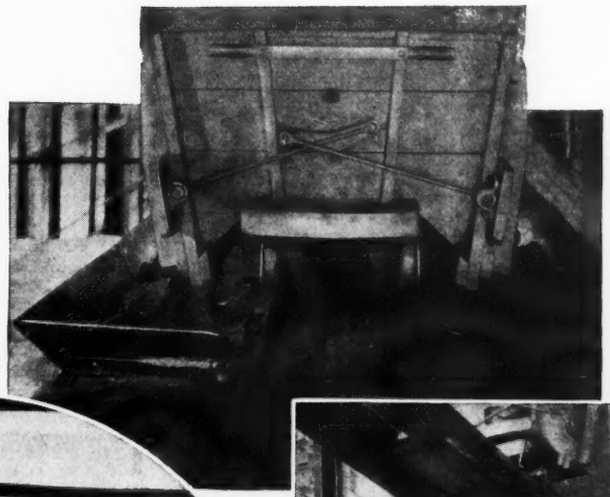
The details of the present installation are shown in the accompanying photographs and drawings. While equipment to burn crushed coal in suspension was developed and described some years ago, it is still a novelty to many power engineers. For that reason details of design and operation will be given.

The first point to note is that the coal is crushed, but not pulverized. In the Waterbury plant a previously installed hammer crusher reduces the coal so that it will pass through a quarter-inch screen. No other preparation for firing is employed.

Following are screen analyses of typical samples as delivered to the furnace.

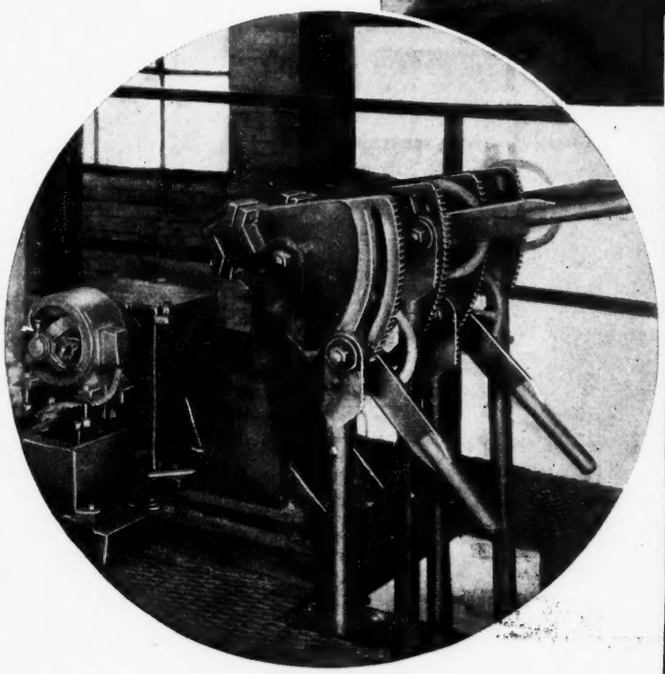
Mesh	Per Cent	
Over ¼ in.	5.1	0.9
Through ¼ in. over ⅛ in.	13.6	27.6
Through ⅛ in. to 1/16 in.	23.7	25.0
Through 1/16 in. to 1/30 in.	22.0	19.0
Through 1/30 in. to 1/50 in.	15.3	11.2
Through 1/50 over 1/100 in.	10.2	8.6
Through 1/100 in. over 1/200 in.	6.7	6.0
Through 1/200 in.	3.4	1.7
Total	100.0	100.0

The presence of a small percentage of pieces larger than ¼ in. is explained by the fact that the hammer crusher forces the coal through ¼-in. slots so that only

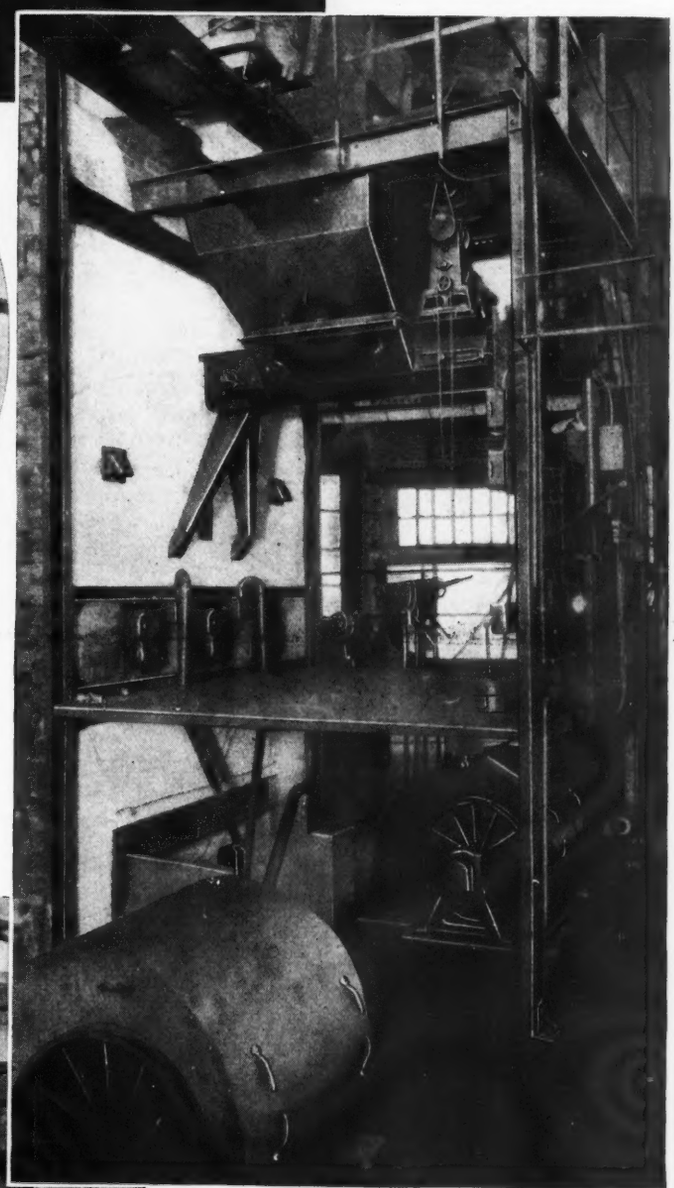


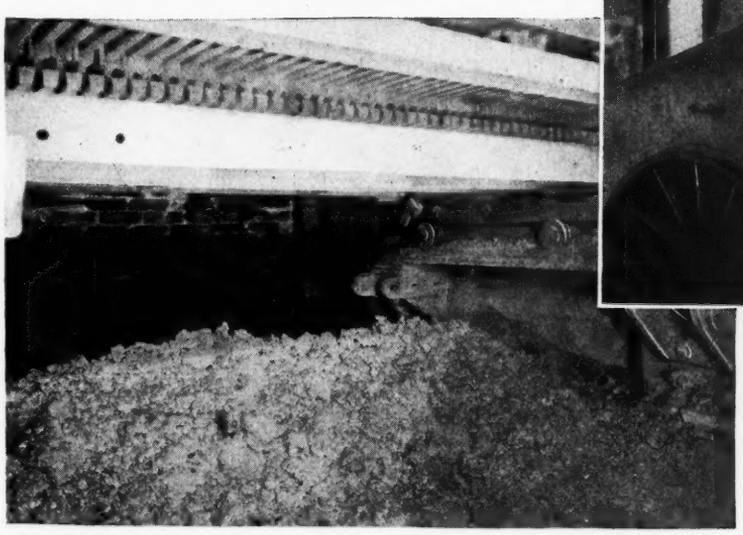
Right—Car dumps crushed coal to feed hopper

Below — Front of boiler showing feeder and control mechanism, also two chutes delivering coal to furnace



Above—Levers control the slot opening and movement of the sliding grates in the throat unit





View taken from beneath the grate in the plenum chamber while boiler was in operation. Note that ash lumps are larger than the coal particles

one dimension is positively limited to this size. The crushed coal is carried by hand truck to a feeder hopper above and in front of the furnaces. From this it is delivered to the firing chutes by a small scraper conveyor motor-operated through a variable-speed drive.

Sliding into the furance by gravity only, the coal falls past a stream of air entering horizontally through a slot at a pressure of about 0.4 to 0.6 in. of water. The importance of this jet should not be overstressed, since it is not designed to furnish primary air and is not essential to the operation of the furnace. It does assist operation by spreading the coal across the width of the furnace.

The principal and essential elements in the furnace design are the inverted pyramid bottom, the horizontal slot through which air is projected upward and the small grate, or "throat," in which the slot is situated.

As a result of the converging bottom, air velocity increases rapidly as one goes down. Each grain of coal therefore finds a certain level (depending on its size, density and shape) where it can float in equilibrium. This level constantly changes as combustion of the particle proceeds.

The relative areas at the top and bottom are such that practically none of the particles can rise as high as the tube level, or fall as low as the slot, until combustion is complete. An exception to this statement may be found in the case of the largest particles at very low "live-bank" ratings. At such loads a small percentage of the coal fired will fall and burn on the grate.

The theory of the ash action in this furnace is not yet fully understood. While the ash is denser than the coal, thereby gaining an increased tendency to fall, the fact that a particle of coal burns to a much smaller particle of ash would appear to work in the opposite direction.

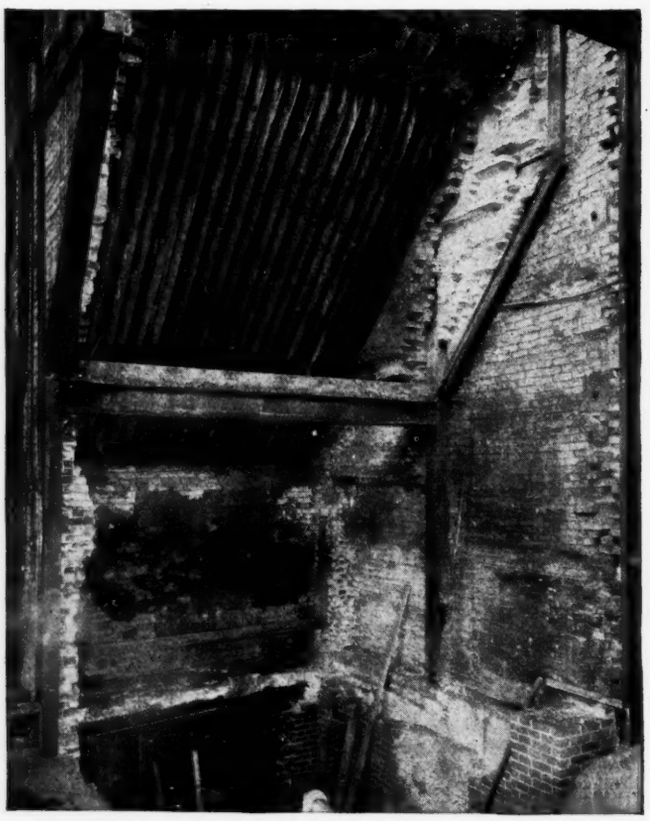
Turning from theory to known fact, it has been found, at Waterbury and other installations of this system, that no detectable amount of ash rises as far as the tubes and that the average screen size of ash in the pit is considerably larger than that of the coal. Apparently, particles of molten ash float around in the turbulent furnace atmosphere, meeting and fusing with other particles until the gobules are sufficiently large to fall to the grate against the upward air stream.

FOUR COALS TESTED
(Factor of Evaporation)

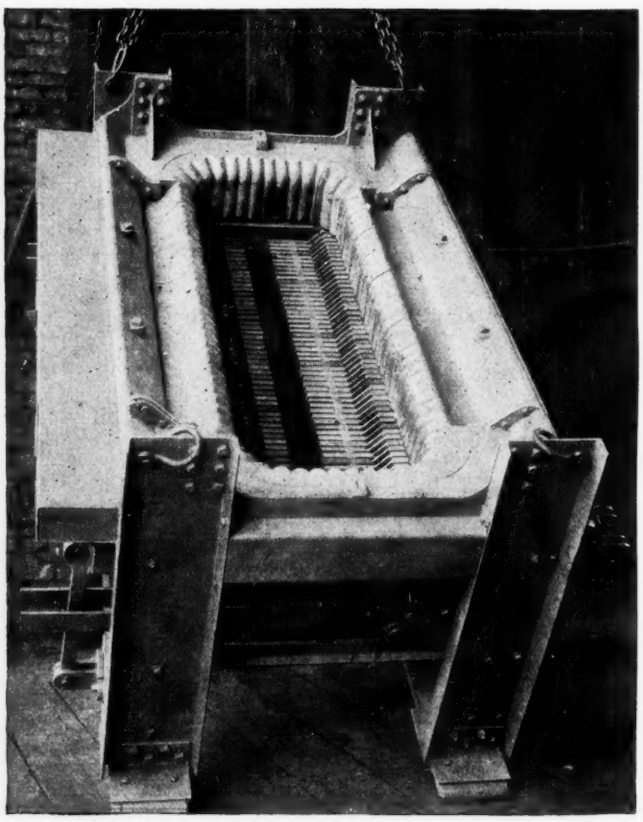
	Preston County, West Va.	New River	Fairmont Slack	Pittsburgh Slack
Sulphur (separately determined), per cent	0.8	1.1	1.0	1.0
Volatile, per cent	29.3	23.3	37.1	34.3
Ash, per cent	12.0	5.9	8.2	8.0
Moisture, per cent	1.8	1.7	1.5	1.8
B.t.u., dry	13,430	14,725	14,010	13,890
B.t.u., as received	13,185	14,480	13,800	13,640
B.t.u., ash-free	15,300	15,650	15,260	15,110
Volatile as fired, per cent	34.0	24.7	40.4	38.0
Fusing temp. of ash, deg. F	2,520	2,300	2,380	....
Mine price	$1.20	Local delivery	$1.10	$1.15
Freight	$3.65		$3.85	$3.85
Trucking	$0.90		$0.90	$0.90
Delivery cost	$5.75	$6.25	$5.85	$5.90
Evaporation as fired, lb	10.08	11.75	10.85	10.40
Cost of fuel per 1,000 lb. steam	$0.284	$0.277	$0.269	$0.284
B.t.u., in fuel per lc. delivered	45,850	46,100	47,200	46,250

A throat unit for this type of furnace is shown below. The length is varied according to furnace capacity, other dimensions and all of the small unit parts being standard.

The grate, it will be seen, is in two layers, each divided into two halves. The lower halves do not move in operation except as they are adjusted slightly to control the width of the slot. The upper halves slide slowly back and forth in unison across the lower grate, making about three four-inch strokes per minute. At each stroke the mixture of coal and ash on one side of the lower grate is pushed over the air jet. Thus the coke particles are blown up into the furnace again, while all ash particles of sufficient size fall through the slot into the ash pit.



Setting of second boiler being altered for crushed coal installation (now complete)



Throat unit, showing adjustable slot and upper sliding grates

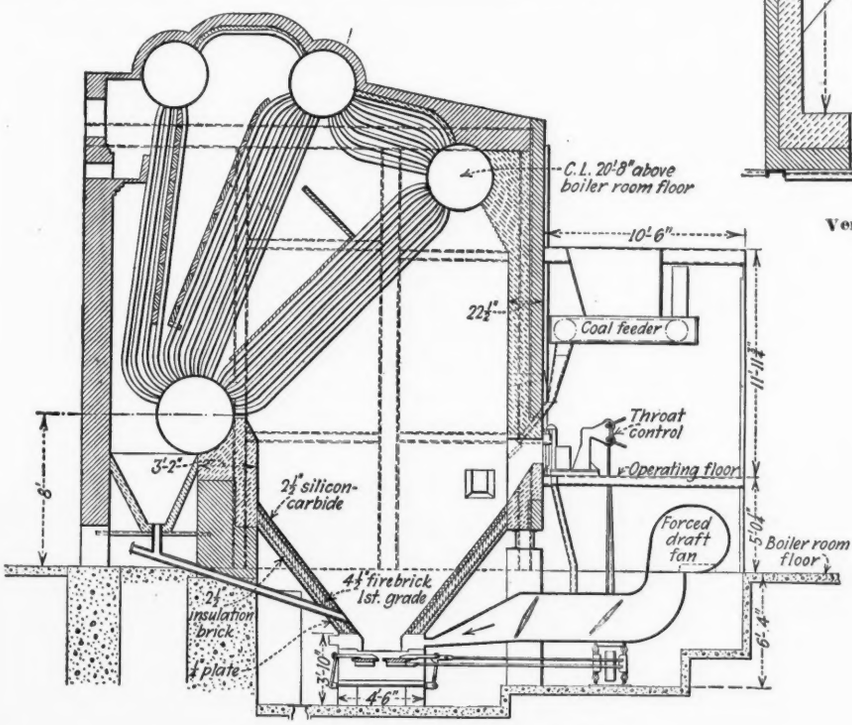
Circulation of intake air through the hollow castings of the throat before admission to the slot cools the throat and at the same time preheats the combustion air.

The grate motions are produced by a motor on the operator's platform, driving through reducing gear, links, cranks and levers.

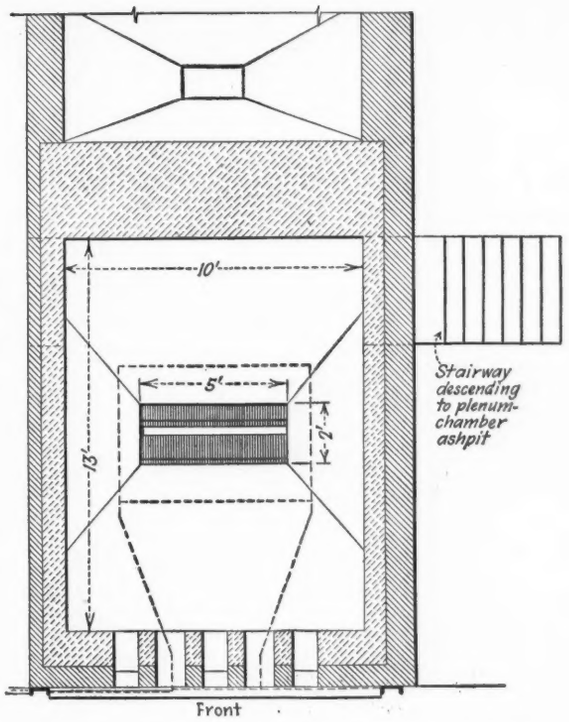
Equipment at the Waterbury plant, which differs in some minor details from other installations, includes two forced draft fans, automatic regulator controlling coal feed and draft damper from the steam pressure, a furnace-draft control regulating the stack damper to maintain 0.03 to 0.05 in. suction, a boiler meter, a five-point draft gage and a CO_2 recorder.

In addition to the automatic regulation of coal and air, hand adjustment is provided to maintain the desired CO_2 or steam-flow air-flow ratio on the instruments.

Mr. Carter made several interesting observations on the operation of this unit. One was that a green operator, without previous experience on pulverized coal or stokers, could quickly be taught to operate the unit consistently at high efficiency. He said that no operating troubles of any sort had been experienced or any difficulty in carrying night loads as low as 25 per cent.



Horizontal section through furnace



Vertical cross-section of Waterbury installation bottom in form of inverted pyramid

What is perhaps his most interesting observation is that the kind or quality of the coal has no measurable effect on efficiency or operation. He has tried out eight different coals, varying in volatile content, heat value, ash-fusing temperature and sulphur content. These ranged from 22 to 37 per cent in volatile, from 6 to 12 per cent in ash, from 2,150 to 2,640 deg. in fusing point, from 12,960 to 14,480 B.t.u. and from 0.8 to 3.4 per cent in sulphur content. All have operated perfectly and with almost identical efficiencies.

As a result of these tests he is now considering buying coal strictly on a B.t.u. basis without regard to other characteristics. In the Waterbury district the cost per million B.t.u. favors high-volatile coal.

Analysis and unit costs for four coals tested are shown in the accompanying table.

Tests of all of these coals at 100 per cent rating have shown over-all efficiencies of boiler and furnace (without economizer) of between 81 and 82 per cent. The CO_2 ranges from 13 to 15 per cent, averaging about 14 per cent.

Monthly efficiencies are naturally somewhat lower, since the boiler normally operates fifteen hours out of each twenty-four at 25 per cent of rating, and for the remaining nine hours at a load ranging from 100 to 150 per cent. The load is 25 per cent from Saturday noon until 7 a.m. Monday.

During the month of August, this year, 4,595,000 lb. of water was evaporated with 435,500 lb. of 14,100-B.t.u. coal (as fired). The evaporation per pound of coal was 10.52 and the equivalent evaporation (with an evaporation factor of 1.077) was 11.35. The resulting boiler and furnace efficiency was 78.1, about 10 points higher than that obtained with the old installation.

Allowing also for a saving in coal cost per million B.t.u., this increased efficiency will represent a fuel saving of about $7,000 per year.

As already pointed out, the second unit has been similarly equipped.

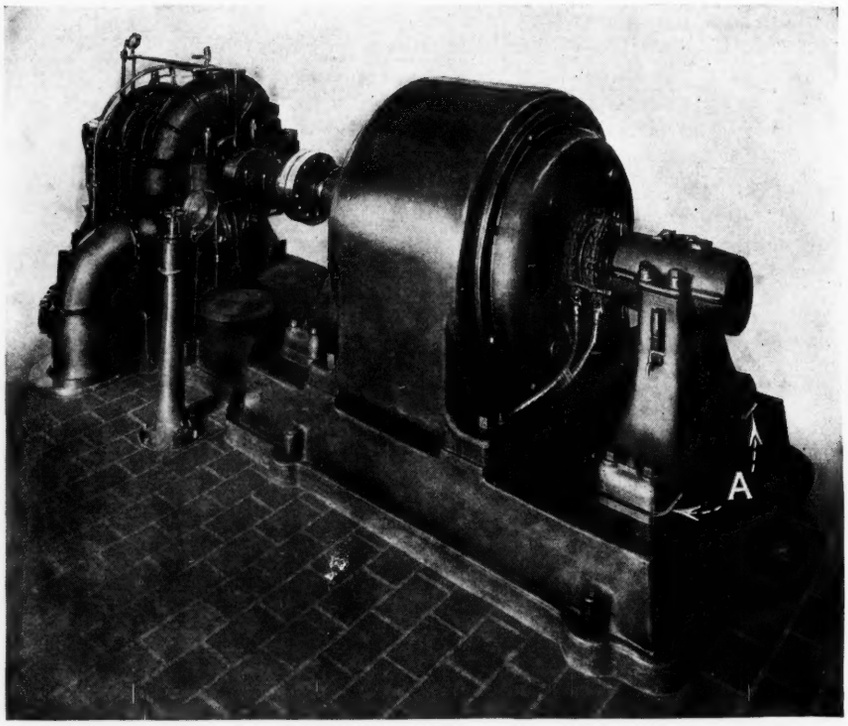
Power is greatly indebted to Mr. Carter for making available his experiences with the plant and for checking the summary as presented in this article. It should be pointed out that this is the first installation of a vertical-jet crushed-coal furnace in New England and that this successful pioneer effort is the direct result of Mr. Carter's personal investigation and initiative.

The fuel-burning equipment was furnished by the Stratton Engineering Corporation.

BEARING CURRENTS

Their CAUSES *and Means of* PREVENTION

By M. E. WAGNER
Cleveland, Ohio



Insulation placed at *A* and around pedestal bolts to insulate the bearing from bedplate

Electric machines sometime give trouble because of their bearings pitting as a result of current flowing through them. The way in which these currents may be produced and how their effects may be reduced or eliminated

CURRENTS flowing between the shaft and bearings of electric machines sometimes cause trouble. These are frequently referred to as shaft currents or bearings currents. When they flow from the shaft to the bearings, or vice versa, they must pass through the oil film, and in doing so they produce minute arcs that may pit the shaft and bearings, cause heating, and have other bad effects.

Bearing currents are produced in several ways. They may be generated from a stray magnetic field that links the shaft, bearing pedestals and bedplate. There are two general causes for this: one, the arrangement of the connections coming out of the machine. For example, in Fig. 1 if the + leads from the machine were all on one side of the bearing pedestal and the — leads on the other, the conductors would produce the condition of a single turn coil around the pedestal and a magnetic field would be set up in the shaft and frame as indicated by the arrowheads. The conditions indicated (Fig. 1), on heavy-current machines, can produce, due to the magnetic pull between the shaft and pedestal, a loading on the bearing sufficiently heavy to cause destructive heating.

With a magnetic field passing from the bearing pedestal to the shaft, as in Fig. 1, the shaft becomes a single-conductor armature, cutting the flux and generating a voltage in the shaft section of the bearing. If the flux is sufficiently dense and the speed high the voltage may be sufficient to break down the oil film and cause a current to circulate between the shaft and bearings, as indicated by the closed loops in Fig. 2. If there are oil rings, the current circulation may be from the shaft to one oil ring and to one end of the bearing, then through the bearing to the oil ring at the other end and to the shaft. Frequently the oil rings do not make constant contact with the bearing and are not very effective in carrying bearing currents. Also, the film of lubrication may insulate them from the bearing and shaft.

The conditions in Figs. 1 and 2 were produced by conductors connecting the machine and load. They can also be caused by improper distribution of the armature, series and interpole leads, which in large, high-speed machines should be distributed so that one neutralizes the effect of the other. When the shaft of a machine is magnetized it indicates that a magnetic field exists in the shaft, bearing pedestals and bedplate. Such a condition does not necessarily mean bearing trouble, but it is well to try and locate the cause and if possible eliminate the stray field.

Squirrel-cage motors with sectionalized end rings may have a magnetic flux set up in their shafts. In a machine with a wave winding, having only one bar per slot, Fig. 3, the currents in the two circuits of the winding incircles the shaft in opposite directions. If the currents in the two circuits are not equal they will cause a magnetic flux in the shaft. But that is not likely to produce serious trouble. P. L. Alger and H. W. Samson, "Shaft Currents in Electric Machines," A.I.E.E. Transactions, 1924, refer to tests made on a large induction motor with such a winding on the rotor. One circuit of one phase was opened and the motor was operated under various running and starting conditions. Although all the current of one phase of the rotor linked the shaft, it was found that only a few millivolts were produced between the shaft and bearings. No sign of bearing currents were found when the machine was taken apart.

Alternating-current machines may have a current induced in their shafts by unbalanced magnetic fields. Consider the four-pole revolving-field machine in Fig. 4. The paths of the magnetic flux are as indicated by the arrowheads. If the magnetic circuits are uniform the

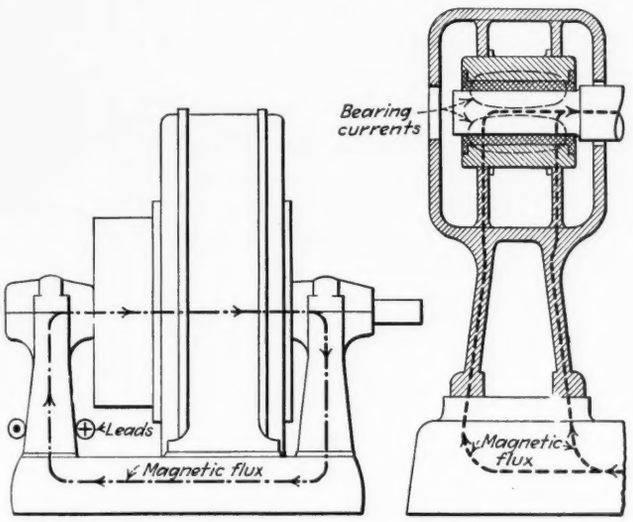


Fig. 1 (Left)—Dotted line shows path of shaft magnetic flux or of shaft currents
Fig. 2 (Right)—The dotted loops show the path of bearing currents

flux will be equal in each path, consequently equally distributed about the shaft. If joints are put in the core, as in Fig. 5, the reluctance of the flux paths through the joints may be considerably higher than through other paths. This unequal distribution of the flux in the different circuits may cause part of the magnetic field to link the shaft. At points E and F in the hub the magnetic field is less dense than at G and H. The result is a tendency for some of the flux passing through G and H to take the easier paths, through E and F, and thus work all paths in the hub at the same density. What happens is indicated by the dotted lines: Part of the flux links from pole A to D, then to C and B and back to A. This flux surrounds the shaft, and if it varies in density a voltage will be induced therein.

Assuming that the rotor moves one pole space, the poles will have the position shown in Fig. 6. Now the core joint is in the flux circuits between poles A and B and C and D instead of B and C and D and A, Fig. 5. The component of the flux that links the shaft is from A to B through C and D and back to A. This flux has also shifted one pole space, by decreasing to zero and building up to normal value again in the opposite direction. This variable flux linking the shaft induces a voltage in it in the same way voltage is induced in a conductor carrying an alternating current.

An unsymmetrical magnetic circuit does not necessarily cause a flux to link the shaft. For example, consider the six-pole machine in Fig. 7, with its core divided on the horizontal diameter, which unbalances the magnetic flux between the different pairs of poles and creates a tendency for the flux to link the shaft as in the four-pole machine. One path for this linkage is from pole F to A, as indicated by the dotted line, through poles A and B to pole C, around through the joint in the core to pole D and through poles D and E to pole F, thus completing the link. It should be noted that one of the core joints is in this linkage. Another path that the linkage might take, indicated in Fig. 8, is from pole F to E, as shown by the dotted line, through poles E and D to C, then through poles C and B to A. in going from A to F the linkage passes through the joint in the left-hand side of the core. It will be seen the linkage about the shaft in both Figs. 7 and 8 includes a core joint, consequently the two are equal and one neutralizes the other, with the result that shaft currents are not generated. It is therefore evident that there can be joints in a machine's core without causing shaft voltages. But it is necessary to distribute the joints so that there is the same number in each magnetic linkage about the shaft. The arrangement of joints in

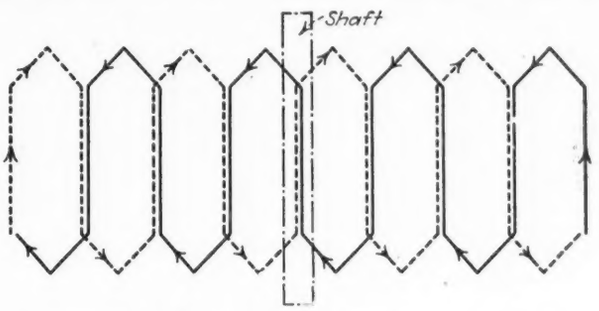


Fig. 3—Diagram of a two-circuit wave winding that may cause shaft currents

the laminations may cause shaft currents just as readily as the joints that divide the core into sections. In machines that have their cores assembled to form a continuous ring it is necessary to select the proper number of joints in the laminations to avoid shaft current.

Where conditions are favorable to the generation of shaft voltages, they increase rapidly with size of machine, and the shaft current may increase at even a greater rate because of the larger bearing and reduced oil film. Length of the air gap is also a factor. With short air gaps, as in induction motors, the possibilities of shaft currents' giving trouble are greater than in machines with long air gaps.

It might be well to note the difference between the conditions in Figs. 1 and 2 and those in Figs. 4 to 8. In the first case the shaft, bearing pedestals and the frame form a magnetic circuit, and a voltage is generated in the shaft by rotating in a magnetic field in the bearings. Current is generated in the section of the shaft in the bearings and circulates in that part of the shaft only (as indicated in Fig. 2) and may rightly be considered bearing current.

In Figs. 4 to 8 a magnetic field has been created around the shaft somewhat similar to the field surrounding a conductor carrying an alternating current.

This field increases and decreases and induces a voltage in the shaft, which causes a current to flow through shaft, bearings and frame. The circuit is the same as the magnetic circuit in Fig. 1. This current may be termed a shaft current, since it is induced in the shaft outside of the bearings. Here the bearings are only part of the electric circuit.

Another possible cause of bearing currents is static discharges. Belts frequently have heavy induced static charges. These charges can pass from the belt to the pulley and shaft and from there to the bearings and frame to ground. It is possible, although not probable, that continual discharge through the oil film might pit the bearings and shaft.

A ground in the windings of a machine may cause a current to flow through the bearings. For example, a ground in the armature of a direct-current generator: ing, where bearing trouble was experienced, and voltages as high as 10. In some cases a spark can be produced by connecting a piece of wire from the end of the shaft to the bearing pedestal and then breaking the contact—a good indication that bearing trouble is likely to develop.

Many factors influence the current flowing between a shaft and its bearings, not the least of which is the thickness of the oil film. In some machines the film may be thick enough to virtually insulate the shaft from the bearings and prevent destructive currents. With the same shaft voltage, in another machine, the oil film in the bearings will not insulate the shaft, and trouble develops. Well-fitted bearings are more favorable to building up a good oil film than those the surfaces of which are not true. It has been found that by improving bearing surfaces shaft currents can be reduced to about

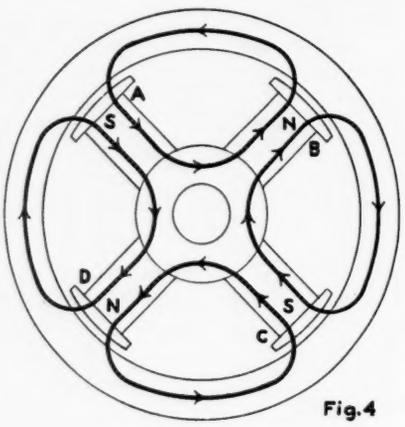


Fig. 4

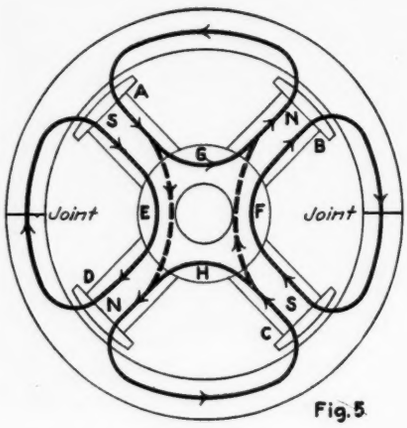


Fig. 5

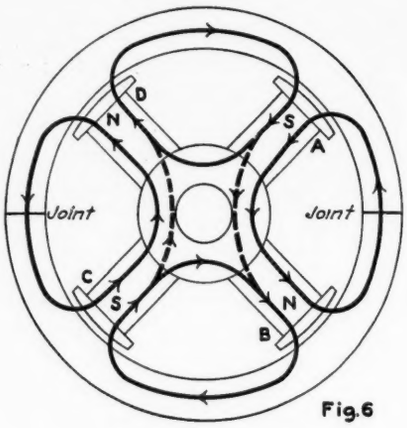


Fig. 6

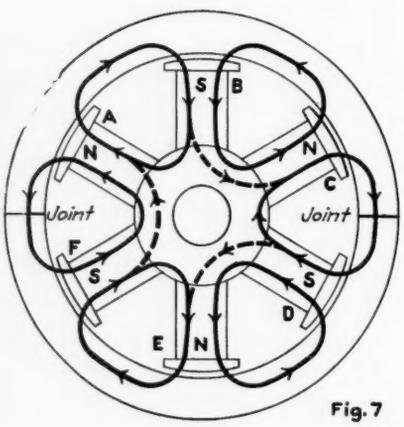


Fig. 7

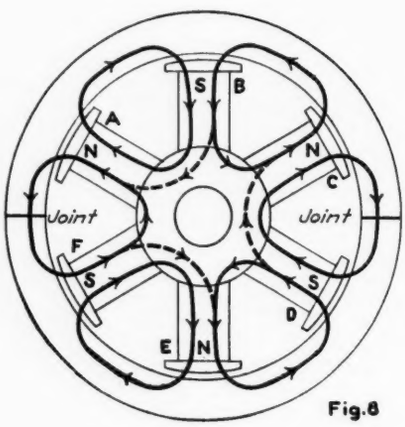


Fig. 8

FIGS. 4 TO 8—MAGNETIC FLUX DISTRIBUTION IN 4- AND 6-POLE ALTERNATING-CURRENT MACHINES

Fig. 4—No joints in the stator core and the magnetic flux is equally distributed in the four paths. Figs. 5 and 6—Joints in the stator core cause a flux to link the rotor shaft and generate currents in it and the bearings. Figs. 7 and 8—Two equally spaced joints in the stator core of a 6-pole machine do not cause the magnetic flux to link the shaft, consequently a current is not generated in the shaft and bearings.

If the frame is effectively grounded and there is a ground on one side of the power circuits, a heavy current may flow through the bearings before the circuit breaker opens. Under severe conditions of this kind, bearings have been injured. Where the frame of a machine is grounded, but the resistance of the connection is comparatively high, a current may flow to ground continuously through the bearings without opening the protective device. Such a condition may not injure sheave bearings, but might be detrimental to anti-friction bearings with their small contact with the shaft.

Many machines have voltages induced in their shafts, but only in exceptional cases great enough to produce destructive currents. Tests show that current on the order of 1.25 amp. per square inch and greater will cause bearing trouble. Other tests have revealed several hundred amperes flowing between the shaft and bearing, where bearing trouble was experienced, and voltages as high as 10. In some cases a spark can be produced by connecting a piece of wire from the end of the shaft to the bearing pedestal and then breaking the contact—a good indication that bearing trouble is likely to develop.

Many factors influence the current flowing between a shaft and its bearings, not the least of which is the thickness of the oil film. In some machines the film may be thick enough to virtually insulate the shaft from the bearings and prevent destructive currents. With the same shaft voltage, in another machine, the oil film in the bearings will not insulate the shaft, and trouble develops. Well-fitted bearings are more favorable to building up a good oil film than those the surfaces of which are not true. It has been found that by improving bearing surfaces shaft currents can be reduced to about one-fifth of what they were with the bearings in poor condition.

End play of the shaft is also a factor in shaft currents. If the collars of the shaft run free of the bearings at both ends the oil films in the two bearings are in series and may effectively insulate the shaft. If the collar on one end rubs hard on its bearing the oil film will be shunted and only the film in the other bearing is in the shaft-current circuit. As a result the oil film of the bearing may fail and the shaft currents may injure the bearing.

The oil rings may also make contact between the shaft and bearings. The first signs of trouble from shaft currents often appear under the oil rings, in the form of scratches on the shaft. This is caused by the oil ring's making good metallic contact between the bearing and shaft. When a heavy current has started to flow, move-

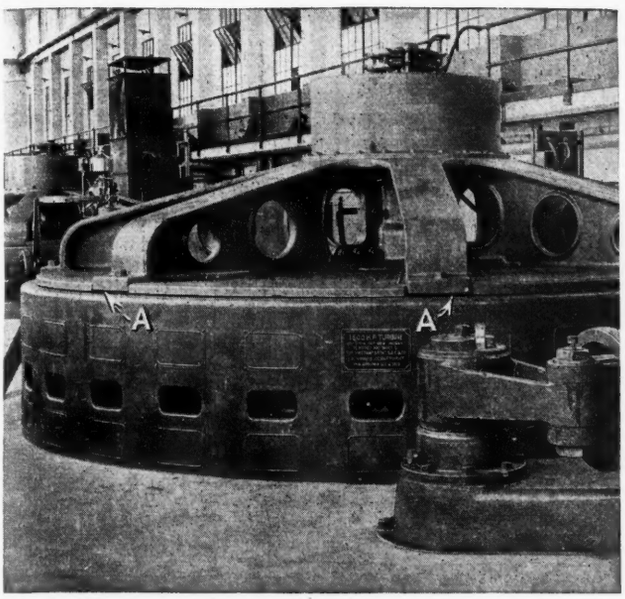


Fig. 9—On vertical-shaft waterwheel generators insulation is placed under the upper bearing bracket, as at *A*, and around the bracket bolts to prevent shaft currents

ment of the ring breaks the circuit and causes a spark that pits the shaft.

Proper machine design is the most desirable method of avoiding shaft current. With a machine in operation and shaft currents causing trouble, remedial expedients must be applied. A common method of preventing shaft currents is to insulate the bearing pedestals from the frame. Where supported in end brackets attached to the stator frame, bearings may be insulated in the housing. However, neither one of these methods is effective in preventing bearing currents produced by a flux in the bedplate and shaft, as in Fig. 1. Non-magnetic material may be introduced into the magnetic circuit to reduce the flux to an ineffective value. One of the pedestals may be made of non-magnetic material; or, generally less expensive and more readily applicable, an opposing magneto-motive force is created in the shaft by a coil, linking the shaft, through which current is passed in a direction to neutralize the flux.

Where a machine has bearing pedestals (such as shown on page 798), insulation about $\frac{1}{8}$ in. thick under one will prevent shaft currents. The bolts and dowels holding the pedestal to the bedplate must also be insulated from the pedestal. It is best to insulate only one pedestal, as the rotor then remains grounded to the bedplate through the other pedestal. A $\frac{1}{8}$-in. insulating plate of the proper shape may be placed under one pedestal and metal plate of the same thickness put under the other and the feet on the stator frame to bring them all in line. If this cannot be done, metal equal to the thickness of the insulation will have to be removed from the bottom of the pedestal or from the bedplate pads where the insulation is used. On vertical-shaft waterwheel generators the upper bearing bracket is insulated from the stator frame, as at *A* Fig. 9. In some installations the thrust bearing is also insulated from its support.

Another method of eliminating the effects of shaft currents is to connect the shaft with the bearing pedestals by brushes, which shunt part of the current around the bearings and may reduce the flow through the oil film to where it is negligible. An objection to this method is its uncertainty. When the brushes are making good contact they may be effective. Undetected, dirt may destroy the metal-to-metal contact of the brushes with the shaft and the bearings may be subjected to destructive currents. Even when the brushes are making good contact they will not shunt more than about 50 per cent of the shaft current from the bearings.

It is also easy to destroy the effectiveness of bearing insulation by piping, etc. Where oil, water or other piping and hand rails shunt the bearing's insulation, insulating joints must be used in the piping to break the circuit. Neglecting these seemingly minor details may be the cause of destruction of large and expensive bearings.

▼ ▼ ▼

A "Dictionary" of Power Hook-Ups

NEXT WEEK'S *Power* will be unique—a whole number devoted to power "hook-ups." These hook-ups, freed from non-essential detail, will show practically all of the important fundamental sequences of major power units. Here, under a single cover, the reader will find more than one hundred combinations with telegraphic comments on the applications of each.

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INSULATION
for Moderate Temperatures

Previous articles of this series dealt with the characteristics of materials used in the manufacture of heat insulation. The author's views on commercial insulation suitable for temperatures up to about 600 deg. are here given

By E. F. ZEINER
The Philip Carey Company

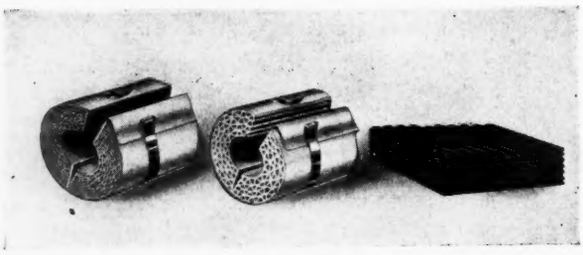


Fig. 1—Types of built-up insulation

COMMERCIAL INSULATION for moderate temperatures may be roughly classified as built up or laminated, molded and felted.

Air cell covering is built up from an asbestos paper unit constructed by cementing a sheet of corrugated paper to a sheet of flat paper. The depth of the corrugations is about ¼ in. A pipe covering section is made by winding the combined unit around a mandrel the same size as the pipe for which the covering is intended. Sheets and blocks of air cell construction are built up by arranging the units to secure equal strength in both surface dimensions of the sheet.

The air cell type of insulation is an inexpensive form of covering. The size of corrugations results in an efficiency that makes its application economical only in low-temperature service such as hot water, low-pressure heating systems and low-temperature ovens. The relatively low insulating efficiency of this form of insulation is readily understood in the light of the facts presented in the first article of this series. It will be recalled that, where air circulation is possible, heat can be carried from one place to another by this air movement. The higher the temperature the more rapid is the circulation. The large ¼-in. corrugation permits relatively free circulation and transmission of heat.

The air cell conductivity curves in Fig. 2 indicate the relative efficiency of this type of insulation at various temperatures. The slope of the air cell curve demonstrates the rapidity with which heat is lost through the covering as the temperature is increased.

Attempts have been made to obstruct the circulation of air in the corrugations of this type of insulation by cross-indenting corrugations. Curve 1 of Fig. 2 shows the conductivity characteristic of an air cell product made with cross-indented corrugations. Comparison of Curve 1 and Curve 2, a high-grade air cell covering of ordinary structure, seems to indicate that no added heat saving efficiency is secured by this cross indentation.

Insulation containing eight plies of corrugated asbestos paper per inch of thickness is considerably more efficient than the corrugated covering previously discussed, as is indicated by comparing Curve 3 with Curves 1 and 2. Eight-ply insulation is manufactured in the same manner as air cell except that the corrugations are

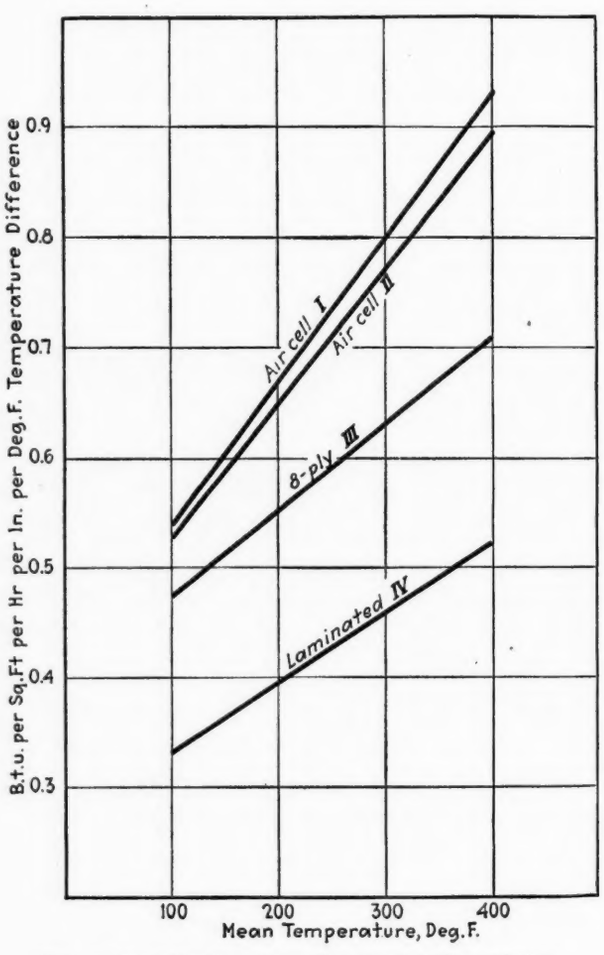


Fig. 2—Conductivity curves for corrugated insulation

only $\frac{1}{8}$ in. deep. An insulating material made of the eight-ply construction has considerably better mechanical strength properties than does four-ply material.

The higher insulating efficiency of eight-ply covering is due to the greater resistance to air circulation which the smaller corrugations introduce. It has twice as many layers to the inch as air cell, and also has a great many more small points of contact between adjacent layers, introducing an increased conduction loss, which, however, is more than offset by the decreased circulation in the corrugations. Economy of operation dictates that this form of corrugated covering be not used for the general insulation of temperatures above 300 degrees.

Another type of asbestos paper insulation is that of the laminated construction. Its insulating ability is obtained by trapping a great volume of small air spaces between adjacent layers or plies of roughened asbestos paper.

A rough or uneven surfaced paper is necessary to secure slight separation between layers in order to entrap finely divided air. Various methods have been used to obtain such separation: (1) small particles of ground corn cob, straw, and sponge have been embedded in an asbestos paper to make the surface of the thin felt uneven; (2) smooth asbestos paper has been used and separation between plies effected by sprinkling diatomaceous earth or similar inorganic material between the layers as the covering is in process of rolling; (3) a smooth asbestos paper has been processed with large and relatively deep indentations to secure an uneven surface.

Each of these methods of manufacture has its own limitations. The first method, using ground organic material as a separating medium, cannot be permanently satisfactory and effective in holding plies apart because the organic material does slowly and surely decompose under heat. This decomposition is accompanied by a decrease in volume of the charred material. The support between layers is removed and the plies tend to come together, reducing the insulating efficiency of the covering, and also introducing the likelihood of the covering's sagging on the pipe. When a covering sags a space is formed between the lower portion of the pipe and the lower half of the covering section. This space gives rise to a flue action and introduces excessive heat loss.

Effecting separation between layers by inserting ground stone or diatomaceous earth overcomes the chemical decomposition of the material discussed above, but has the disadvantage that under vibration the powdered material tends to shift and collect in the lower portions of the sectional covering. This shifting introduces the possibility of sagging and increased heat loss. In addition, this method of manufacture produces a heavy insulating material, whereas light-weight insulation is preferred so that the load on piping systems may be reduced.

A third method of manufacture eliminates the disadvantage of the two methods just discussed. However, the use of too large indentation results in poor insulating characteristics because the size of the air space between plies may be such as to permit less restricted circulation of air, resulting in greater transmission of heat from layer to layer.

The use of a reasonably pure asbestos felt, that is, a felt containing a minimum of binder, processed so as to secure minimum convection loss through the covering, is ideal for this type of insulation, because there is but a small percentage of material in the covering which can possibly deteriorate over years of service.

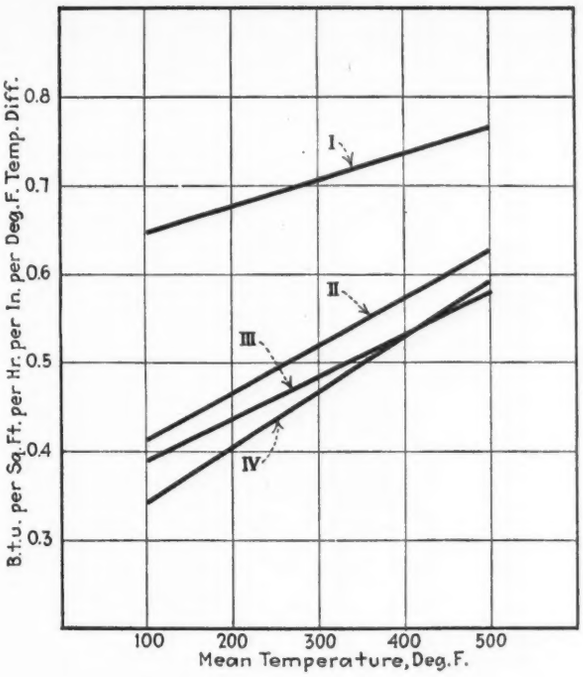


Fig. 3—Conductivity curves for laminated insulation

Research has improved the structure and manufacturing methods of laminated asbestos covering by determining those factors which influence the conductivity characteristics and durability of this form of insulation. Study has conclusively demonstrated that the construction of the asbestos felt, the type of asbestos fiber, the thickness of the asbestos felt, size and number of annular air spaces and amount of contact between layers all affect the rate of heat loss.

The number of layers or plies per inch of thickness of the laminated type of covering varies with the brand and manner of manufacture. It should be borne in mind that the method used in the manufacture of laminated insulation is the factor which determines the number of layers per inch of thickness. The maximum insulating value for a covering constructed of an asbestos felt roughened by means of embedded organic material may require thirty-five to forty layers per inch of thickness. A covering using a practically inorganic indented felt may require only twenty-seven to thirty layers to give maximum insulating efficiency. It does not follow, however, that because the latter method calls for fewer layers, it is a cheaper product to manufacture or has lower insulating value. Curves in Fig. 3 illustrate this point. Curve 3 is for a covering of approximately forty layers per inch and Curve 4 for a covering of twenty-seven to thirty layers per inch of thickness.

In order that the laminated type of insulation be practical and convenient to handle, the successive layers must be cemented together. It would not be feasible from a heat-saving point of view to cement the layers throughout because of the reduction of available air spaces and the increase in conduction loss through the covering. Therefore, it is the practice to cement the layers of laminated insulation together at intervals of two to three inches by narrow bands or rings of fire-resistant adhesive. In view of the conduction loss introduced by the adhesive material, there should be as few of these bands or rings as consistent with satisfactory strength and rigidity of covering.

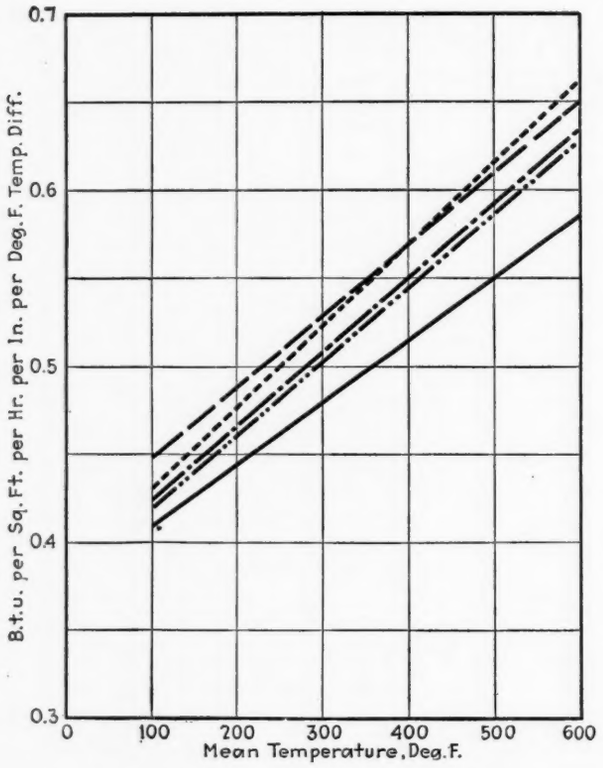


Fig. 4—Conductivity curves for four brands of 85 per cent magnesia

It is a characteristic of laminated asbestos insulations that they can stand up under adverse shipping and service conditions with little breakage.

Eighty-five per cent magnesia, standard insulation in many industries for a great number of years, is a molded product. The carbonate of magnesia, after being mixed with the proper amount of asbestos fiber, is pumped into molds where the excess water is permitted to drain off. Then the plastic mass is removed from the molds and placed on wire-mesh form supports, loaded upon racks and placed in heated chambers where the material remains until thoroughly dry. After drying, the rough material goes to milling machines, where it is dressed down to proper thickness. The sectional covering is machined to fit the size of pipe for which it is intended; two half sections are then mated and a canvas jacket is cemented around them.

Sectional magnesia covering is furnished in standard thickness for pipes up to and including 10 in. in diameter. For pipe sizes above that curved or segmental blocks are made of such width that a specific number of segments fit around the pipe without cutting.

Molded block insulation is manufactured in identically the same manner except that the jacketing process is omitted. Broken blocks, sections and trim are ground up and either go back into the mix or are bagged as 85 per cent magnesia cement.

Carbonate of magnesia starts to calcine at a temperature of about 500 deg. F. This chemical change is accompanied by a loss of cohesiveness between crystals, which renders the material somewhat less resistant to vibration and impacts. For that reason it is not considered advisable to use 85 per cent magnesia for the insulation of surfaces much above 550 deg. F., especially when it may be necessary to remove and re-apply the materials, as excessive breakage is liable to result.

The average conductivity curves of four brands of 85 per cent magnesia as reported by R. H. Heilman, Fellow of the Mellon Institute, are reproduced in Fig. 4. The conductivity of any of the brands is only about 10 per cent above or below a mean value.

Diatomaceous earth insulation is molded in a manner generally similar to the process used for 85 per cent magnesia. A high percentage of carbonate of magnesia is mixed with the diatomaceous earth to act as a binder for the diatomite, which has no natural cohesiveness. Asbestos fiber is also included to give additional strength. However, such insulations have been found to have a somewhat brittle structure.

Since this form of insulation contains a high percentage of carbonate of magnesia in addition to diatomaceous earth, the maximum temperature at which such a combination can be satisfactorily used is limited largely by the calcination of the carbonate of magnesia.

Another type of insulation that has received consideration by engineers in certain industries is manufactured from limestone. The rock is melted in a cupola and as the molten material flows out the stream is broken up by a jet of steam or air which fiberizes and cools the material. The fiberized stone is collected in a large chamber, cut into strips of various thicknesses and formed. This material generally comes in sheet form and is usually 2x4 ft. or 2x8 ft. The sheet is fastened between facings of chicken wire or expanded metal lath. Pipe covering sections are also furnished.

The thermal characteristics of this type of material are about the same as 85 per cent magnesia at mean temperatures of 350 deg., but it is easily compressed or distorted. The fibers of which the material is made are extremely brittle and the fine splinters may penetrate the skin of men applying it. However, there are uses for this type of insulation where these disadvantages have but small influence and where it can be installed with little handling.

[The next article in this series will discuss commercial types for high temperatures.—EDITOR.]

Low-Voltage May Cause Overheating of Motors

IN AN induction motor the torque varies as the square of the voltage applied to its terminals. This causes this type of motor to be more sensitive to voltage changes than others whose torque varies approximately as the voltage. Most induction motors are designed to operate satisfactorily on voltages 10 per cent below normal, when the frequency is at rated value. A 10 per cent decrease in voltage reduces the motor's torque to 81 per cent of what it was at full voltage. At the end of a long overloaded line the voltage may be considerably less than 10 per cent normal. At a voltage of 20 per cent below normal the motor's torque decreases to 64 per cent of what it was at normal voltage. Under such conditions, if the motor is driving nearly its rated load, it may take an excessive current from the line and overheat, many instances of the kind being on record. When trouble is experienced with induction motors overheating, one of the first things to check is the voltage at their terminals.

High frequency has the same effect as low voltage and a combination of the two may cause overloading of induction motors, even when the voltage is apparently within the 10 per cent limit.

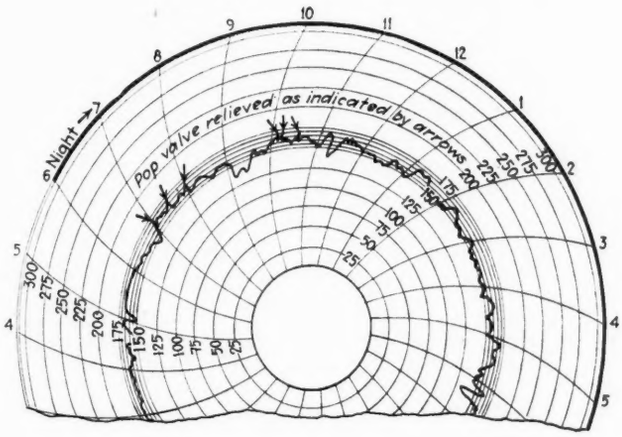
. . . RIGHT OUT OF THE PLANT . . .

Method of Eliminating Waste of Steam From Boiler Pop Valves

IN MANY power plants frequent blowing of the boiler pop valves is a continual source of annoyance and a waste of steam. The civil authorities have prescribed certain pop valve sizes and piping arrangements and law demands their use, so there is no argument. We must have pop valves on our boilers, and for those in charge to know that they comply with the requirements they should be caused to operate daily.

In many industrial plants where power is generated and low-pressure steam is used for process and heating, much of the steam that under the conventional arrangement is escaping through the safety valves can be put to useful work.

An arrangement that has worked ideally in one plant is shown in the accompanying drawing. A pop valve is shown bypassing the reducing valve. The pop valve is set to blow at a pressure about 1 lb. lower than the regular pop valves on the boilers. As the pressure approaches the popping point, this valve relieves first, and usually discharges sufficient steam to keep the regular pop valves from opening. In this case we are using a two-inch high-lift pop safety valve. The normal boiler load is around 30,000 lb. of steam an hour at 160 lb. gage, and this size is working out very satisfactorily. It will also be seen that there is a two-inch check valve on the discharge side of the pop valve. This is necessary because the low-pressure steam varies and would change the popping point of the valve, but by using the check valve and placing a small vent between the check and pop valve atmospheric pressure prevails in the body of the valve above the seat. This arrangement eliminates the effect of any change in pressure on the low-pressure mains, particularly effective where there is a sharp variation in the load and the noise of the pop valves is objectionable at night.



Pop valve connected to bypass reducing valve and discharge to low-pressure main

By placing a tee below the pop valve, as shown, with a leading side pitot tube connected to a recording pressure gage, both steam pressure and the time and duration of the popping are recorded, as shown by the chart actually produced under this arrangement.

The effect on the morale of the operators is as great, or perhaps greater, as the value of the steam saved. As an unquestionable record is made of the actual popping that takes place in the plant, steps can be taken to curtail it if the wastage is excessive. This arrangement is equally effective for recording time and duration of blowing when placed on the main pop valves of the boiler.

S. C. PAGE.

Rochester, N. Y.

The Banked Fire: A Neglected Opportunity

I HAVE READ with interest the article, "The Banked Fire: A Neglected Opportunity," by R. K. Long in the Aug. 5 number. In conjunction with radiation, the major loss from a banked fire, little effort has been made to diminish the cost of banked fires in heating boilers.

Boilers supplying low-pressure steam for building space heating are offenders, with their daily operation under conditions unfavorable to economy throughout the greater part of the heating season.

This stand-by loss is often not preventable with existing equipment and fluctuating demands, yet it may be

minimized and savings established with intelligent planning and foresight.

It is not my intention to enter into the details of any heating system design, but a few words concerning combination systems would seem to be in order.

Many installations of heating boilers are much too large for the amount of steam they are to generate on an average; they are often proportioned, in a single unit, for a peak load that exists but a few days of a heating season. To keep the steam pressure within certain limits the engineer is forced to run with banked fires the greater part of the heating season.

A little foresight on the part of the heating engineer could have minimized the inefficient operation of these boilers, granting that he was not compelled to provide for future requirements that could not be accurately determined when the size of boiler was chosen, which still does not relieve him of his responsibility as to efficient boiler operation under varying weather conditions.

The most economical boiler installation for space heating results when the boiler rating is considerably less than the maximum requirements.

The total boiler capacity required should be spread out into two or three units and on 150 per cent load basis, to provide flexibility during varying weather conditions without using banked fires with their attendant losses of heat.

If the boiler is already installed, alterations in the setting will be necessary to provide for air insulation that will intercept the heat radiating from a banked fire and transmit it to a location where it may be used to advantage. When this warm air may be used for building space heating, or any heating and drying operation, it will be necessary to design a setting with a view of securing a balance between the supply and demand for warm air. For positive circulation installation a fan and ducts will be necessary.

This warm air may be heated by contact with the boiler's external surface or by contact with brickwork that receives its heat from other brickwork in contact with the fire. The heat that is intercepted is mostly absorbed and little is radiated from outside boiler walls, thus minimizing the major loss of a banked fire.

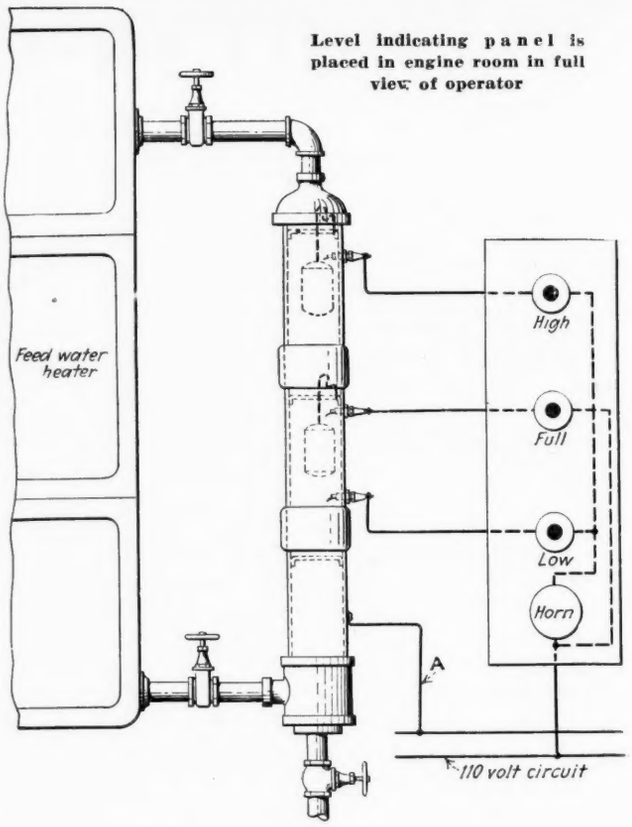
Brooklyn, N. Y. WILLIAM ANDERSON.

Electric Alarm Systems for Feed-Water Heater Level

DESIRABILITY of an electrical alarm system to indicate the water level in a feed-water heater is necessarily a question of individual station design, and the primary purpose of such a system is the convenience of station operatives, as well as a booster of the over-all station safety factor.

There are many stations in which the feed-water heater is so located that the operator can readily observe the water level. In these stations an alarm system would be of no material advantage. There are also many instances where the water level is not visible from the operator's station. There an electrical alarm system will contribute much to the localization of the operator's duties.

I am familiar with one station where such conditions exist. The feed-water heater is at the top of the boiler room, and to see the water level in the gage glass attached to the heater it is necessary for the operators to climb a distance of about 55 feet.



Level indicating panel is placed in engine room in full view of operator

Difficulty is experienced at various times in maintaining a sufficient water supply, owing to irregularities in the service of the filter plant from which the supply of make-up water is obtained. During these periods it is important that the water level in the heater be known constantly so that water may be obtained through another source of supply.

In this plant the arrangement is such that in the event of high water there is danger of water from the heater flowing into the exhaust line to the boiler feed pumps; so it is necessary at all times to know the water level in the heater. It is obvious that an alarm system is indispensable here. The general arrangement of the alarm is shown in the illustration.

The system is essentially a water column so arranged that floats establish an electrical contact with wires leading to a panel on the control platform through the medium of spark-plugs. Three short lengths of four-in. pipe connected by couplings form the main body of the column, and give greater accessibility to the floats, spark plugs, guides, etc. The column is connected top and bottom by one-inch pipe with a gate valve in each connection. A blowoff line, with a valve in a convenient position, is brought down from the bottom of the column.

In the float chamber three guides of sheet iron extend horizontally across the pipe, as shown in the illustration, and serve to hold the floats in their respective positions. The spark plugs are in the side of the column at the point where the high-, full- and low-water zones begin. To the tip of the spark plugs are soldered copper strips $1\frac{1}{2}$ x $\frac{1}{2}$ in., to establish a contact between the floats and the spark plugs sufficient to carry a current strong enough to light the lamps and blow the horn on the control panel. The lights on the panel are arranged to

reflect through the words "high," "full" and "low" outlined in stained glass. The horn is connected to blow for high and low water.

Directly attached to the top of each of the floats is a wire that extends upward and over to a point on the upper guides. The float chamber is connected electrically by means of wire *A*, and inasmuch as the upper guides are directly attached to the float chamber the floats serve to complete the circuit between the column and the spark plugs.

In operation, this system has been found to serve satisfactorily the purpose for which it was intended. There are undoubtedly other stations where it might be applied to advantage. W. B. BURKE.

Greensboro, N. C.

Corrosion in Heating Returns

SOME TIME AGO I had to investigate a plant having trouble with corrosion in heating returns. The following is the method used in attacking the problem and a suggested means of preventing further corrosion and cost of apparatus and savings that may be effected:

Examination of plant log showed an annual expenditure of $967.52 for boiler compounds. Extensive tube replacements owing to corrosion had been encountered and return distribution lines had failed. In studying this problem reference was made to "Separation of Dissolved Gases From Water," by J. R. McDermot; "Corrosion Causes and Prevention" and "Corrosion in Steam Heating Systems," by F. N. Speller; and "Boiler Feed-Water Purifications," by S. T. Powell.

On the Efficiency of Deaërators, Powell states, "The amount of iron which may be converted into rust by oxygen carried by water is very great. For example—anywhere from 1,800 to 2,500 lb. of rust may result in a year when the feed-water consumption is 10,000 lb. per hour and dissolved oxygen content of approximately 0.06 per cent by volume." It has been demonstrated that when feed water is heated to 200 deg. F. the oxygen and carbon dioxide are liberated.

F. N. Speller in his paper on "Corrosion in Steam Heating Systems" makes the following recommendations:

1. Preheat water to drive off CO_2.
2. Thoroughly deaërate water before entering boiler.
3. In low-pressure steam boilers (less than 5 lb. pressure) most corrosion occurs in the returns, and excess of caustic soda and an equal amount of sodium sulphate should be maintained in boiler water. The hydroxyl alkalinity should be at least twice the carbonate alkalinity. This may be controlled by testing samples of boiler water and the condensate.
4. All returns should be sealed to prevent unnecessary air leakage into the system.
5. Boilers to carry sulphates at least equal to alkalinity to guard against caustic embrittlement.
6. In using caustic soda, add for this purpose sufficient sodium sulphate to comply with this recommendation. In practice, add enough caustic soda to give excess of 100 parts per million in boiler.
7. Corrosion in steam heating systems is confined mainly to the returns and varies widely in different localities and sometimes in the same locality, due to variations in water and operating conditions.
8. In high-pressure plants the water should be preheated to remove CO_2 and scale-forming matter without leaving more than a slight excess of sodium carbonate. The water should be thoroughly deaërated before entering the boiler.

Upon completion of the study it was determined that a 10,000-gal.-per-hour hot-process water softener used in conjunction with a deaërating feed-water heater would eliminate the formation of scale. A hot-process water softener to take care of 60,000 lb. of feed water per hour would cost about $6,000, and a complete unit, consisting of deaërating heater and hot-process water softener, and including erection, would cost approximately $10,000.

The annual fixed charge on this equipment, including depreciation, interest at 6 per cent and maintenance, would be around $1,186.66, or $3.24 a day. In addition, the average cost for materials used per day would be approximately 62c. To this should be added labor for cleaning sedimentation tank, 1 hr., at 40c., and power (32 kw.), at 3c. per kilowatt-hour, 96c., giving a total cost per day of $5.22. This would give:

Cost per year (5.22 × 365)		$1,905.30
Estimated 10 per cent saving in coal bill		6,344.50
Saving in boiler room labor:		
Former cost (2 men at $1,500)	$3,000.00	
With new equipment	$1,000.00	
Net saving		$2,000.00
Saving in feed-water cleaning		120.00
Total saving		$8,464.50
Less annual cost of operating softener		1,905.30
Net saving effected		$6,559.20

The plant now spends $967.52 for boiler compound alone and requires constant repair service amounting to over $1,000. ROBERT HUGHES.

Washington, D. C.

New Basic Principles Needed

WHILE I fully endorse the suggestions contained in the editorial "New Basic Principles Needed," in the Sept. 23 number, I should point out that you have given Doctor De Laval credit for only half of the steam pressure which he applied in 1897. In that year six De Laval high-pressure units, two of 50 hp. and four of 100 hp., were furnished to supply electrical energy at the Stockholm Exhibition; while two other units of 100 hp. each supplied all of the power required at the De Laval Steam Turbine Company's shop at Jarla, Sweden. The date of starting the latter plant was March 9, 1897, which undoubtedly marks the first time in history that power was supplied commercially by the use of steam at around 3,000 lb. pressure. The boilers were designed for a working pressure of 2,850 lb. per square inch., but were tested to 5,700 lb. per square inch, while the log of the work mentions pressures of 3,100 and 3,420 lb., or above the critical pressure of steam, and also shows that temperatures of 700 to 750 deg. F. were used.

It is also of interest that steam at these pressures was supplied directly to the turbine nozzles and not first passed through a reducing valve, as is the practice with the present-day Benson boiler. Except for occasional tube failures in the forced-circulation boilers, due to the use of unpurified feed water, these units operated satisfactorily and without incident. Other "modern" ideas incorporated included independent control of the primary air beneath the grate and secondary air above the grate, air preheating, air-cooled furnace walls and combined boiler and turbine units. GEORGE H. GIBSON.

New York City.

From Among Readers' Problems

Conducted by

L. H. MORRISON

EVAPORATION WITH OIL—*During a conversation with several engineers one of the men quoted that 80 to 85 per cent boiler efficiency was being obtained for every day in the year in their plant. The boilers are equipped to burn oil. They are also equipped with economizers.*

I doubted the efficiency and stated hat under the circumstances an evaporation of 16 lb. could be effected, which, with oil at 18,000 B.t.u. per pound would make the evaporating efficiency 75.4 per cent, which I believe is the actual result the plant is obtaining. They stated that no oil is allowed for bringing boilers to steaming point, which no doubt affects the efficiency. Should we include economizer in boiler efficiency? F.F.

The inclusion of economizer heat recovery in calculating boiler efficiency depends upon what is desired. The A.S.M.E. test code has an item for the boiler efficiency including the economizer and also an item for the efficiency not including the economizer. If the economizer is not to be included, the feed-water temperature is that at the boiler inlet and not at economizer inlet.

Probably the difference in the stated boiler efficiency and the efficiency you think is actually obtained is due to the use of the "low-heat value," which would, of course, cause the efficiency to be much better than if the "high-heat value," which does not make allowance or the water vapor lost in the flue gases, were used. A sustained efficiency of 80 to 85 per cent with oil is, to say the least, remarkable.

POWER FROM GARBAGE—*Is it possible to obtain power from garbage?* J.M.P.

This is being done in a number of places. Garbage contains about 87 per cent combustible, of which about 50 per cent is carbohydrates. In a recent study, C. T. Schreiber estimated that in a city of 1,000,000 people the refuse averages two pounds per day per capita. Hence about 50,000 kw.-hr. could be generated by the burning of this refuse. The power produced would probably exceed the demands of the disposal system.

Garbage is usually disposed of in a furnace, with no attempt to generate steam.

STEAM CONSUMPTION OF SIMPLEX PUMPS—*We have two 12x7x12-in. simplex house pumps, rated for 120 gal. per minute at 60 strokes, working against a head pressure of 65 lb. and operated with steam at 120 lb. What should be the steam consumption in pounds per minute? The water is supplied to the pumps from one open storage tank.*

I intend to replace one of these pumps with a screw-type pump driven by a 7½-hp. motor rated for 150 gal. per minute.

We make our own power, burning oil under our boilers, and produce 130 to 135 lb. of steam per gallon of oil at a cost of $0.03845 per gallon. Would this change be advisable, economically? C.J.R.

The steam cylinder of the pump is 12 in. diameter x 12 in. stroke, so that, at 60 strokes per minute, the steam piston displacement is

$$V = \frac{0.7854\ D^2 \times S \times N}{144 \times 12}$$

where D is the diameter, S the stroke in inches and N is the strokes per minute. Substituting actual values,

$$V = 0.7854 \times \frac{12 \times 12 \times 12 \times 60}{144 \quad 12}$$

= 47.124 cu.ft., neglecting the space taken up by the piston rod.

The water head pressure is 65 lb., so that the steam pressure in the pump steam chest necessary to balance the water pressure bears an inverse ratio to the water pressure of the squares of the diameters, or the average steam chest pressure is $65 \times \frac{49}{144} = 31.85$. Adding 25 per cent for frictional losses, the average steam pressure must be 39.8, or say 40 pounds.

At 40 lb. gage the volume of 1 lb. of steam is 7.78 cu.ft.; therefore, the piston displacement per minute would require 6 lb. of steam. To care for the clearance steam and the cylinder condensation, this would be increased about 50 per cent, making the total 9 lb. per minute, or 540 lb. per hour.

You say you are evaporating 130 lb. of steam per gallon of oil. Assuming 8 lb. of oil per gallon, this is almost 90 per cent efficiency, which is too high.

On the basis of 130 lb. of steam per gallon of oil, the 480 lb. of steam calls for approximately 3.7 gallons.

The problem may be attacked from another angle. The weight of the water pumped is $120 \times 8\frac{1}{3} = 1{,}000$ lb., the head is $2.3 \times 65 = 150$ ft. The water horsepower is $\frac{150 \times 1{,}000}{33{,}000} = 4.6$ horsepower. The steam rate of such a pump will be about 125 lb. per hour, a total of 575 lb., not far from that calculated at first.

The water power, as before stated, is 4.6 hp., which, if frictional losses are included, will run to about 6 hp. The efficiency of a 7½-hp. motor carrying a 6-hp. load is around 85 per cent, so that the kilowatt demand will be about 7 hp., or, say, 5.25 kw. It would be safer to assume an engine water rate of about 50 lb. per kilowatt-hour; so the pumps will require 462 lb. of steam, while the steam pump will use about 575 pounds.

INTERPOLE MOTOR SPARKS AT THE BRUSHES—*We have a 25-hp. direct-current compound-wound motor with interpoles that is giving trouble by sparking at the brushes. When operating as a compound motor, with the interpole winding cut out, the machine runs satisfactorily, but when the interpole winding is connected into circuit the brushes spark badly. We have tried about every remedy on the motor, but have failed to make it operate satisfactorily as an interpole machine. What would you suggest?* C.S.S.

Apparently the fault is in the way that the interpole field coils are connected into circuit. The polarity of the interpole coils can be checked by passing a current through them and testing them with a compass or small piece of iron. Where the number of interpoles equals the number of main poles, their polarity when they are correctly connected will be alternate north and south.

A Question for Our Readers

IF IT IS DESIRED to burn the same amount of coal with natural draft, will the stack be the same height at sea level and at an elevation of 7,000 feet? D.C.

Suitable answers from readers will be paid for and published in the Dec. 30 number

If the number of interpoles equals one-half the number of main poles they all have the same polarity.

After it has been ascertained that the coils in the shunt, series and interpole windings have correct polarity, start connecting the different field windings into circuit. First, connect the interpole winding in series with the armature and move the brushes or the commutator a few segments in the direction it is desired to have the armature turn. Then apply power to the motor and note its direction of rotation. If the direction is the same as that in which the brushes were shifted it shows that the interpoles have correct polarity in relation to the polarity of the armature. If the armature turns opposite to the direction in which the brushes were moved, the connections of the interpole winding to the armature should be reversed to give them the correct polarity with relation to the armature.

After the interpole coils have been connected correctly, shift the brushes back to the neutral position. When the brushes are in the neutral position the armature will not turn in either direction when power is applied to it and to the interpole windings. When the interpoles have been connected correctly, connect in the shunt-field winding to make the armature turns in the right direction and bring the motor up to speed as a shunt interpole machine. After it is operating satisfactorily as a shunt machine, shut it down and open the shunt-field winding and connect in the series-field winding and start the motor. If the motor runs in the right direction, then it may be stopped and the shunt-field winding connected back into circuit and operated as a compound machine. If the motor turns in the wrong direction with the series-field and interpole windings in circuit it shows that the former has the wrong polarity and should be reversed and the direction of rotation again checked before connecting in the shunt winding.

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NON-FREEZING HEATING SYSTEM—*We operate a small hot-water boiler and continuous coils heating system in an insolated building that is not always in use. It is possible to charge the system with some liquid that will not freeze in case the temperature drops to —40 deg. F.?* B.MCK.

If the cost of glycerine and industrial alcohol were not so high, the best solution would be to employ one of these fluids, with the preference to glycerine, as it is less dangerous in case of a leak.

Confronted by the high cost factor, the next solution would be the use of calcium-chloride brine, of a strength such that it would not freeze at —40 deg. F. To avoid corrosion, milk of lime could be added to make the brine slightly alkaline. It should be remembered that the brine will foam much more readily than will water, because of the increased surface tension, if the boiler is forced to the boiling point.

PREVIOUS QUESTION

Discussed by Readers

THE QUESTION

OUR oil engine is insured and recently a cylinder head fractured. In arriving at the present worth of the head before fracture what should be taken as the average life of a head? C.V.R.

THERE is perhaps no definite rule that can be followed for the depreciation of an oil engine cylinder head. In my own experience with three different makes the cylinder head of one type failed three times in one year.

Usually it is customary, in appraising a power plant, to allow twenty years as the economic life of engines, boilers and auxiliaries, it being assumed that such parts subject to wear, like pistons, plungers, packings and valves will be kept in repair.

Unless defective originally, and the break will usually reveal this, a cylinder head, I believe, should last as long as the cylinder, and I should assume the twenty-year life for the machine and depreciate accordingly.

If the cylinder head in question failed because of a defect in manufacture, from faulty operation or from improper functioning of some other part of the machine, then the matter is open for arbitration between the owners, the engine builder and the insurance adjuster, and a reasonable compromise must be arrived at as to the allowable depreciation from the original cost.

It should be remembered, too, that the replacement cost of the head is probably greater, as a repair part, than the cost the original head bears to the total cost of the engine originally.

Troy, N. Y. ROLAND PAGE.

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ARRIVING at the payment to be made by the insurance company is merely another version of the old "horse-trading" game.

The purchaser of the horse, the part taken by the insurance company, who buys the cylinder head, cannot agree that the horse is anything but decrepit —the legs are wobbly and spavined, and the whole critter so near to death that the buyer would be doing a favor in taking it as a gift. On the other hand, the horse (or cylinder head) owner sees only a beautiful saddle thoroughbred with unmistakable signs of the Morgan strain. The animal has Horse Show possibilities.

Starting from these divergent viewpoints, the buyer and seller finally reach a common agreement as to what the horse is worth. If the buyer is the better student of human nature, he gets the horse at a bargain; if not he pays high for a plug of uncertain qualities

In determining upon the payment for the cylinder head, the same dickering occurs. The insurance company urges that an engine part has an extremely short natural life, and because the part has already exceeded its expected life, it had no present worth immediately before the accident. The owner, with the engine salesman's siren song still ringing in his ears, usually feels that an engine part has such a long life that even after twenty years of use it is still as good as new. Somewhere between these extremes lies the actual present worth of the head.

I advise that as a first step the engine owner retain a successful horse trader as his representative — the insurance company will probably need no horse trader for protection.

DONALD MCFEE.

New Orleans, La.

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OFFHAND, I should say that a cylinder head is everlasting, barring accidents and faulty construction. Many manufactures put a ten-year limit on any machine and amortize the cost accordingly, even though at the end of that period the machine may be running perfectly as planned by the builder.

A ten-year limit is assumed because improvements and new processes may render a machine so obsolete that its operation is not so efficient as one of a later pattern. Some manufacturing plants are abandoned because their product can no longer be marketed profitably because of changed conditions. So it is well to write off machinery in a short time.

I should insist that the insurance company replace the head and pay for any accidents caused by its breakage. Loss of time and production cannot be charged against the insurance unless specified in the policy. The insurance company may be able to show that the machine is so old or obsolete as to have no market value as a second hand machine. L. R. BAKER.

Cleveland, Ohio.

BOILER-WATER CONDITIONING:

Maintaining Concentration of Chemicals

In a paper on "Safe Operation of High-Pressure Boilers at Sea," R. E. Hall, director of the Hall Laboratories, told the Annual Safety Congress at Pittsburgh, Sept. 29 to Oct. 3, how to maintain a desirable concentration of conditioning chemicals. Prefacing his remarks with the statement that the general problem of boiler-water conditioning is identical for land and marine boilers, he said, in part:

BECAUSE it is exact, boiler-water conditioning is marked by simplicity. Two chemicals suffice, namely, one of the sodium phosphates, to prevent formation of scale; and caustic soda, or less preferably, soda ash, to obtain proper adjustment of the boiler-water alkalinity and thus protect against corrosion, foaming and boiler-metal cracking. These are standard heavy chemicals purchasable in pure form on the open market.

One invariable rule suffices in their use, namely: Maintain in the boiler water the minimum of both phosphate and alkalinity that will suffice for their respective purposes. This is no rule of mere economy; it is vital to safety. More than the minimum of either the phosphate or alkalinity, and especially the latter, is helpful in inaugurating, or accelerating, foaming or wet steam conditions.

However, from the standpoint of safety, limitation of the boiler-water alkalinity to its minimum is of even greater significance. Alkalinity is the Dr. Jekyll and Mr. Hyde of boiler-water conditioning. In extremely low concentration it is protective to the boiler metal; but used under uncontrolled conditions it becomes the most insidious of enemies to boiler metal.

Control of the Boiler Water

Having emphasized the necessity for exactness in controlling the boiler water conditions, I shall now briefly outline the methods that make this exactness a simple matter for the operators of the boilers.

A sample of boiler water is drawn from blowdown line, water column blowdown, or other point that assures a sample representative of the circulating boiler water. The higher the operating pressure the more essential it is that the sample under pressure pass through a cooling coil, to avoid change because of flashing of steam.

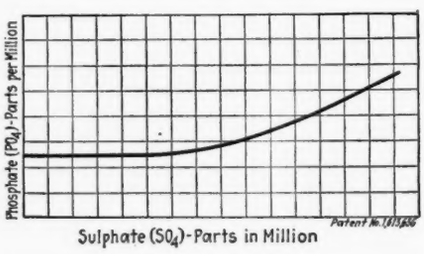
A part of the sample, cooled to room temperature, is titrated with standard acid to determine its alkalinity. The burette and the standard acid for titrating constitute merely a yardstick for measuring alkalinity, and the measurement is as simply made as a measurement of length with an actual yardstick.

To another portion of the sample, from which any sludge has been removed by filtering, appropriate ingredients are added, and if phosphate is present the water turns blue. The amount of phosphate is determined by matching this blue color with the appropriate member of a series of standard blue shades.

To a third portion of the boiler water sample, with sludge removed, ingredients are added which render it milky in character if sulphate is present. The amount of sulphate is found by determining the degree of milkiness, by finding how much the solution must be diluted to allow light to pass through it.

The readings as taken are set down on record sheets. These sheets should be retained as a permanent log, to serve as a history of boiler-water conditions maintained in case any development in the boiler should require reference thereto.

The curve here shown typifies what phosphate and alkalinity ought to be present in the boiler water for the concentration of sulphate found. If the



Phosphate conditioning curve

phosphate is low, the operator increases (and if high, decreases) the amount he is feeding to the boiler water. Likewise, if the alkalinity is low or high, he varies the amount of caustic soda appropriately. In this simple manner he has complete control over maintenance of desirable conditions of phosphate and alkalinity in the boiler water.

The boiler-water alkalinity should be maintained at the lowest value compatible with protection from corrosion. With deaëration of feed water as complete as possible, and under the very best conditions of boiler water, my recommendations would be to maintain from 2 to 5 gr. per gallon of caustic alkalinity in the boiler water; under ordinary conditions, from 4 to 8 gr.; but if chloride concentration is relatively high, the concentration of caustic alkalinity must be higher somewhat in proportion. At the higher operating pressures, the essential concentration of caustic alkalinity for high chloride concentration would be greater still; but the better answer in this case—in all cases, in fact—is to decrease condenser leakage, thus reducing the chloride concentration in preference to increasing that of caustic alkalinity.

Certain ratios of sodium sulphate to total alkalinity in the boiler water are recommended by the A.S.M.E. Boiler Code for protection from the caustic type of boiler-metal cracking. These range from 1 for operating pressures of 150 lb. or under, to 3 or over for pressures above 250 lb. The key to simplicity in maintenance of these ratios is low, carefully controlled alkalinity in the boiler water. In the ratio of sodium sulphate to boiler-water alkalinity we may obtain the desired quotient either by making the numerator (sodium sulphate) large or by making the denominator (boiler-water alkalinity) small. The latter alternative represents greater safety to the boiler, better quality of steam and greater economy of operation. It is uneconomical to be careless in control of boiler-water alkalinities and then attempt to overcome the ills thereof by adding excessive amounts of sodium sulphate to the boiler water. Expense of the sodium sulphate may be negligible; but outages of boiler due to superheater failure or turbine trouble caused by carryover of boiler water in the steam are too costly to tolerate if avoidable.

To illustrate the foregoing, take, for instance, the largest boiler in the world, which has already delivered 1,650,000 lb. of steam per hour at 400 lb. pressure. Make-up water, about 3 per cent in quantity, is New York City water. Cooling water for condensers is the salt water from the East River, so that conditions are approximately the same as those obtaining on ocean-going ships. The city water make-up is a good quality for boiler-feed purposes, but any condenser leakage is high in scale-forming bodies, and a trouble-maker unless properly cared for.

The chemical used for conditioning the water to prevent scale formation is sodium phosphate. The chemical for adjusting properly the alkalinity in the boiler water, and thus protecting against corrosion, is caustic soda. That they may be added to the feed water most simply, and within reasonable limits, in proportion to the feed water, they are

dissolved in a tank of water (both in the same tank) and allowed to flow by gravity into the feed water through an orifice of appropriate size. The phosphate conditioning curve specifies the requisite phosphate- and alkalinity-concentration for the boiler water.

Consider just what this maintenance of phosphate means. Phosphate combines with calcium to form calcium phosphate, which is insoluble and an extremely finely divided substance, so that as it forms it remains in circulation in the boiler water, and is removed when the boiler is blown down. We know, of course, that some calcium is present in the make-up water, and as this arrives in the boiler each atom of calcium becomes joined to phosphate, whereby its possibility of forming scale is immediately removed. Some calcium comes also from condenser leakage, but, as it arrives at the boiler, its fate is similar to that of the calcium from the make-up water: It is joined to phosphate, and therefore cannot form scale. So long, then, as the phosphate maintained in solution in the boiler water serves as a reception committee to meet each incoming calcium atom, and combines with it, scale, in theory, cannot—and, in practice, does not—form.

When he first uses this system the boiler operator does not know how much phosphate to dissolve in his tanks. But he dissolves a few pounds and starts it flowing into the feed water. At the end of several hours, or a day perhaps, he draws a sample of boiler water and tests it as described above, to find if he has any phosphate therein to meet the calcium atoms. If he finds none he increases the charge to the tank a few pounds, and again tests after a few hours. He may or may not find phosphate in the boiler water. If he does not, he increases the charge again, and keeps up this procedure until the phosphate is present in the desired amount, and he knows that every entering calcium atom is met by phosphate and disposed of.

Consider the case in which, with phosphate being maintained in the boiler water and everything going smoothly, suddenly the test on the boiler water shows no phosphate present. That can mean only one thing, namely, that some condenser tube is leaking and a new and greater supply of calcium is getting to the boiler. Is it necessary that the operator let scale form, Not at all. He immediately increases the rate of flow of phosphate chemical, tests again in an hour or so, and keeps on increasing the chemical until it is again present in the boiler water. Thus, whether the leak is mended quickly or not, the boiler surfaces do not suffer, being just as thoroughly protected by use of more chemical as they were before the leak developed, when less chemical was used.

For the higher operating pressures in the marine field, it is germane to this discussion to answer the question whether evaporation is an essential for the small per cent of make-up water. Wherever the heat balance is such that installation of evaporators is economic, they should be installed. Also, the advantage of as high a percentage of condensate return as possible is apparent. On the other hand, these are not indispensable adjuncts to that cleanliness of surfaces essential for uninterrupted continuity of operation, and the engineer designing a plant need not necessarily sacrifice other desirable features or go to uneconomic costs to include them, but may exercise his best judgment for greatest utility and economy.

Evaporation of make-up water is an aid to water conditioning, but cannot supplant it. At higher pressures especially, exact maintenance and limitation of boiler-water alkalinity is essential. Also, condenser leakage and carryover of evaporator are sources of calcium that, disregarded, readily bring unhappy consequences to evaporative surfaces. Safety of all boilers, regardless of pre-boiler arrangements and operating pressure, demands careful maintenance in the boiler water of those conditions known to render it innocuous to the metal surfaces.

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This Thing Called Research*

By CHARLES F. KETTERING
Director
General Motors Research Laboratories

IN THE DAWN of things, groups of our ancestors were moving flat rocks —about six men to a rock—dragging them up a hill. One of the men slipped on a pebble and fell. While sitting there he began to think, "If *I* slipped on this pebble that rock will slip on a pebble, too." So he broached the idea to some of the graybeards who were directing the job. They told him that the best thing he could do would be to go back and put his shoulder to the rock and help push. However, he placed some little round stones in front of the rock and much to the delight of those pushing, it moved easier.

That was probably one of the first examples of research. Crude, but effective. And it was a young man who saw it. He had against him, as we have today, the whole of experience. The world hates change, yet it is the only thing that has ever brought progress. The problem of instilling into industry the importance of systematic change-making which will keep step with everyday progress of the scientific world is one of the greatest contributions that research can make.

If anyone went back and picked up the products that were made ten years ago and tried to sell them today, he would fail. That is because of the change. One thing is the point of view. The day that a person is born, every one else in the world is older. One year from that date there are 2,500,000 people younger, and at the age of 26 there are just as many young as old people, but the trouble with many executives is that they still look to the older people for guidance. Turn around and look at the 60,000,000 people who are younger, who have new ideas and new things.

We must recognize that every new generation comes into this picture without knowing some of the hardships we experienced. Therefore, it looks upon the same facts from a completely different point of view. Entirely apart from the scientific relationships of research, if there is one function more important than another, it is this: To make people recognize that we are living in a state of change.

Self-satisfaction is one of the world's worst diseases.

Let us assume there is an excuse for research. What kind of research is it that you want? Do you want a research department with a nice brass rail around it which should be charged up as an advertising luxury? Or do you want the kind that fits into your particular business, helps outline its future policies so that the company will grow from year to year to a better position, so that it will better its products? Those are the two choices and, if your research department doesn't pay something or lay a foundation for the business, it is a white elephant. Personally, I want industry to consider research as a self-sustaining operating department.

Misdirected research is as bad as no research at all. Some people seem to think research is a panacea for all the ills of modern industry. All the concern has to do is set up a laboratory, hire engineers, and its future prosperity is assured. But nothing could be more ridiculous. Before the research comes the problem and not vice versa. We have a great tendency these days to set the cart before the horse.

Here is another point I wish to make. The research problem is not solved with apparatus. No one has ever solved anything in a research laboratory. It is solved in a man's head. The research laboratory is the means through which likely ideas may be made practicable.

After we have our problems solved and the improvement can be produced economically, just what value can we attach to it? As an illustration let us

*Excerpts from an article published in the October issue of *Executives Service Bulletin* of the Metropolitan Life Insurance Company.

take one of our latest model cars and seal it in a glass case—the premise being that the automobile would change in no way, shape or form, no matter how long it is allowed to be there. We look at the price on the tag and find it is $2,000, so we write that on the case. Let us come back a year from now and look at that car. It does not look as good as it did last year and we think that the price of $2,000 is too high. The high-pressure salesmen think they can get $1,800, so we write that down. The next year we come back and write $1,600. At the end of ten years, no one but the junk man would put a price on it, even though it is as perfect a car as it ever was.

The car certainly did not change, because that was the premise. The eye on the outside looking through the glass has changed. Values do not exist in materials, they exist in the minds of the people who are going to buy. After two years we noticed the appraised value was $400 less than the initial appraisal. Subsequent improvements have made the old model $400 less desirable. That difference represents the premium attributable to research.

There is one thing that I believe should be especially stressed as the basis of industrial research—a healthy dissatisfaction with what we have. An Englishman said of New York that it will be a great city when it is finished. People who are annoyed at the constant change of roads, the detours, the oncoming of new car models, the swift obsolescence of machinery and ideas, are also saying the same thing about this country. It will be a great country when it is finished. But we all know that it will never be finished, that our people are not satisfied with finished things, that they constantly are seeking new improvements which it is the task of research to unfold and discover.

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Perak River Hydro-Electric Development in India

AMONG the Federated Malay States, Perak is one of the foremost in tin production, and it was with a view to supplying its numerous tin mines with power that the Perak River Hydro-electric Power Company was formed in 1926, according to *The Engineer*, London. The Chenderoh power station is situated between two high banks of the Perak River on a solid granite foundation. The dam normally produces a head of 60 ft. Under flood conditions the water level below the dam rises more rapidly than in the reservoir above, and the effective head may fall to 33 feet.

The dam, for the greater part, is a hollow reinforced concrete structure of the Ambursen type, and is slightly curved in the upstream direction to obtain the best rock foundations and a sufficient length of spillway. At the break points and on the left bank, however, it is constructed as a solid gravity dam.

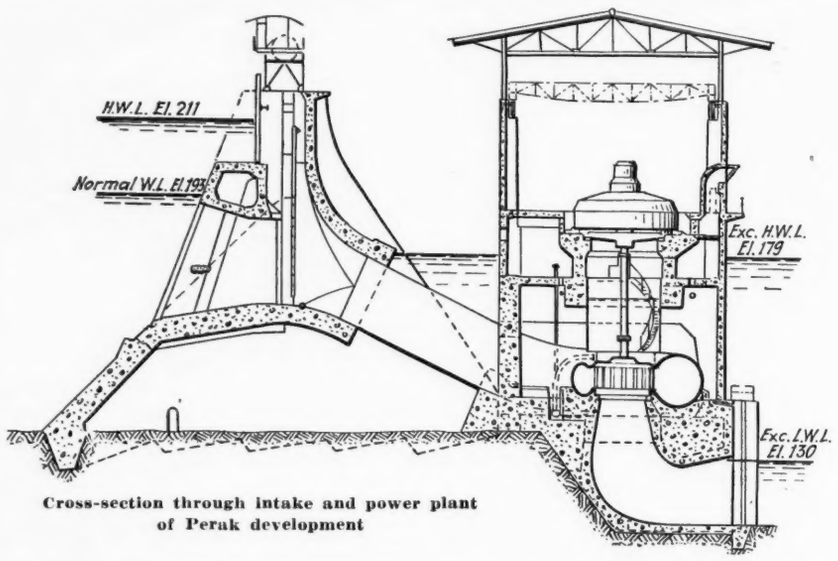
The power house, close behind the intake, is a reinforced concrete building having three main floors. The lower floor supports the turbines, the draft tubes of which form part of the substructure. During floods, when the tail water level is high, the turbine floor is flooded, and to protect the turbine covers there is a steel casing 18 ft. in diameter reaching up to the floor above and accessible from it. This floor, 31 ft. above the turbines, is used for cables, pipes and various auxiliaries, while the generator floor forms the main floor of the station. Strong reinforced concrete columns support the girders for the traveling cranes in the generator room.

A switch house on the upstream side of the power house at the land end contains the battery room, 6,600-volt switch cubicles, and a staff room in the basement; on the generator floor level are the control room, superintendent's office and entrance.

The turbine spiral casings are connected to the intake by short self-supporting steel penstocks. There are three turbines, each coupled to a 9,000-kw. generator. The turbines are of the vertical-shaft Francis type, with steel spiral cases and a single runner. They are designed for 9,025 kw. when using 2,000 cu.-ft. sec. at a head of 53 ft. and a speed of 93.8 r.p.m. The runners weigh 20 tons each, have a maximum diameter of 12 ft. 4 in., and are constructed of cast steel with mild steel cast-in blades.

Each generator connects directly to its turbine by a 20-in.-diameter hollow-bored steel shaft. Because of their low speed, the generators are large, being 26 ft. across the stator. They are rated at 11,250 kva. at 0.80 power factor, and generate 6,600-volt. 3-phase, 50-cycle current. The stators are sunk below the floor level, and ducts are formed around them into which the hot air from the machines is discharged and led out of the building. Cool air is drawn in at the center of the machines from the generator room by fans on the rotors. The rotor rings, because of their large size, could not be transported to the site in one piece. Consequently, the hubs and spiders were made with a split across the diameter. The rims are composed of laminations dovetailed to the ends of the spider arms and were built up on the site. The poles are pressed into other dovetails on the outer edges of the rotor rims and are keyed in position.

Each generator is directly connected to a bank of transformers (without the interposition of oil switches) and both are operated as one unit. Each transformer bank is composed of three single-phase, oil-immersed, water-cooled 6,600 to 66,000-volt units of 3,650 kva. rating, delta connected on the low-tension side and star on the high-tension, there being one spare unit. The oil is cooled by circulating it through an oil cooler supplied with water from the reservoir. The water discharge from the cooler is passed through an ejector connected to the turbine cover drainage system, the arrangement acting as an automatic stand-by in the event of the failure of the drainage pump. The transformers are of the outdoor type and are in the outdoor switch station, together with the 66,000-volt circuit breakers and isolating switches.



Cross-section through intake and power plant of Perak development

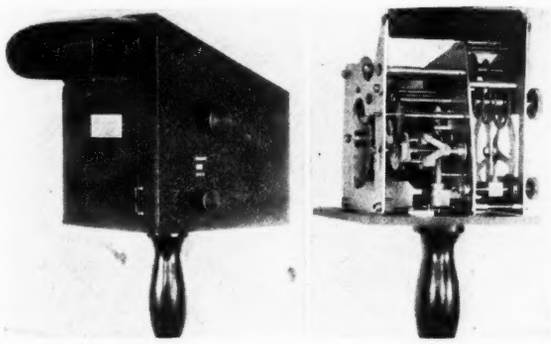
This plant operates on a power system in parallel with an 18,000 kw. steam plant, having three 6,000-kw. turbine-driven units. Steam is produced at 225 lb. gage and 660 deg. F. total temperature by four boilers. The fuel is coal from local mines and is burned in pulverized form.

WHAT'S NEW IN PLANT EQUIPMENT

HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING, TRANSMITTING AND APPLYING THE POWER SERVICES

Rotoscope Gives Speed or Slow-Motion Study of Rapidly Moving Machine Parts

THE ASHDOWN Rotoscope, illustrated, which has been used in England for a number of years, is now being introduced in this country by Livingston & Southard, Inc., 17 Battery Place, New York City. The instrument operates on the stroboscopic principle, and with it periodic motion, whether rotary, oscillatory, vibratory or reciprocating, can be observed and studied and the speed of a moving object can be determined without physical contact. Slow-motion study and exact timing at any speed from 100 to 40,000 movements is possible.



View of Rotoscope complete and with outer case removed

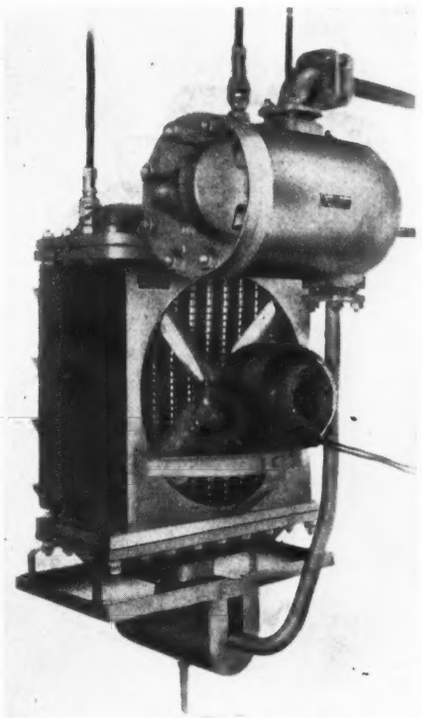
An important feature of the instrument is the rotary cylindrical shutter, capable of giving as many as a thousand glimpses a second blended into a continuous impression. The speed of the shutter can be varied by rapid adjustments with a small five-speed gear box. Fine adjustment of speed control is secured by a special centrifugal governor that is said to give an accuracy within 0.5 per cent.

As the instrument is operated by clockwork, it requires no electrical connection. The operator simply holds the instrument in his left hand with the shutter aperture to his eyes, and adjusts the speed with the right hand. By setting the speed of the shutter at exactly the speed of the moving object, the latter appears to be stationary. Its speed can then be read on the side of the instrument. Slow-motion study can be made by increasing or decreasing the shutter speed slightly. Some of the principal uses are synchronization, determination of speed losses from friction or slip, and the observation of vibration and deflection.

Unit Cooler for Refrigeration

DESIGNED especially for refrigeration and for use with direct-expansion ammonia, brine and other refrigerants, the unit cooler put out by the Grinnell Company, 260 West Exchange St., Providence, R. I., takes the place of the conventional pipe-coil system used in storage boxes and other rooms where refrigeration is required. In addition to effecting a considerable saving in space for a given capacity, the unit is said to replace more than ten times its weight in pipe coils.

The design incorporates straight, short tubes of seamless steel placed vertically to avoid gas-locking. Tubes have radiating fins with collars pressed on. All parts of the cooler, including tubes, sheets, headers, etc., are rust-proofed or processed to prevent corrosion. The housing is of lead-coated iron. A totally inclosed ball-bearing motor drives the fan, which has a steel processed hub and aluminum blades.



Rear view of cooler, showing fan mounting and liquid-level control

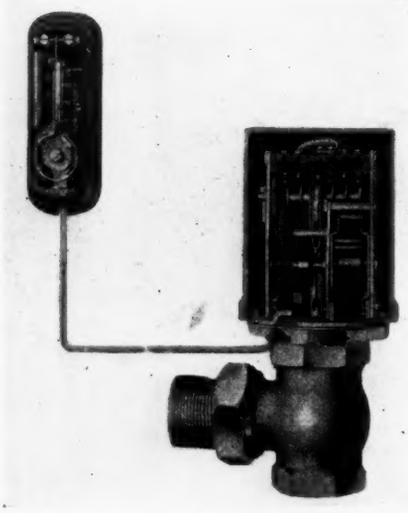
An important feature of the cooler is a specially designed liquid-level control to automatically maintain a positive level of ammonia or other refrigerant in the cooler. Over-all dimensions of the unit, including drip pans, are 23 in. deep, 23½ in. wide and 42 in. high.

Electric Temperature Control System

A NEW electrically operated system of temperature control put out by Barber-Colman Company, Rockford, Ill., designated "Barcol," incorporates a bimetallic loop-type thermostat and a motor-operated radiator valve.

The valve is actuated by a small induction motor of the shading-ring type operating through a gear train and a two-roller cam. Flexible metal bellows type of packing in the valves eliminates packing troubles and the usual friction on the valve stem. A feature of the control is the provision for short circuiting the thermostat and closing the power circuit to the motor. This is done by a cam in the valve-actuating mechanism and takes place soon after each cycle begins.

The system is suitable for use with practically all types of steam heating installations, including indirect heating, combination direct and indirect radiation, zone control of building, etc. It can also be adapted to control oil and gas burners, stokers and damper regulators. When used with oil or gas burners the last valve of the series controlled by one thermostat has its auxiliary contact connected to a relay switch in such a manner that the burner starts when any valve or any number of valves are opened. The valves are available in angle, straight-way, right- and left-hand corner patterns, in sizes from ½ to 2 inches.

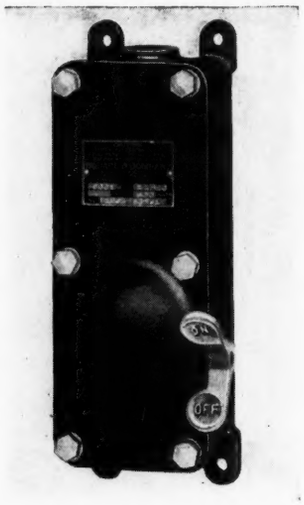


Motor-operated valve with thermostatic control

Explosion-Proof Control Station

A CAST-IRON HOUSING with machined joints incloses the Type BR10 explosion-proof control station announced by the Industrial Controller Division of the Square D Company, Milwaukee, Wis.

The housing is sufficiently strong to withstand internal explosions without transmitting the flame to the surrounding gaseous atmosphere.



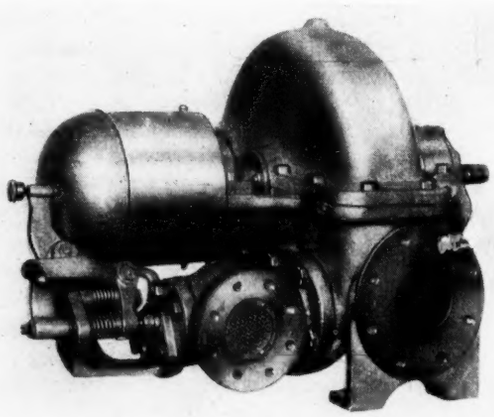
Switch for use where explosive mixtures or gas may exist

The inclosure is provided with two compartments, one of which is used for the contact mechanism and the other as a connection box. The contact mechanism consists of one normally open and one normally closed contact.

New Mechanical-Drive Non-Condensing Turbine

A NEW small mechanical-drive non-condensing steam turbine suitable for driving centrifugal pumps, fans and similar industrial equipment operating in general at speeds between 1,750 and 3,600 r.p.m. has been announced by the General Electric Company, Schenectady, N. Y.

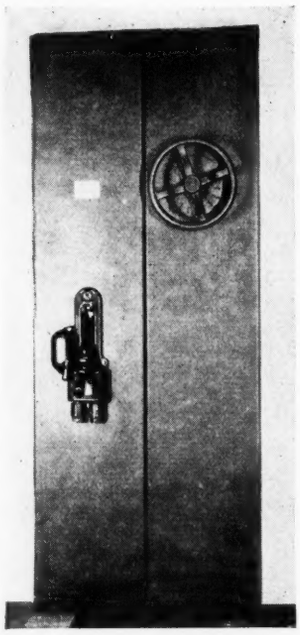
The new unit is built only in single-stage with two rows of revolving buckets. The wheel casing is split horizontally and the steam and exhaust pipes are connected to the lower half of the machine. A centrifugal governor provides speed regulation and an independent emergency governor is also included.



Type D-57 mechanical-drive turbine

Starters and Speed Regulators for Wound-Rotor Induction Motors

FOR USE where it is desired to have complete control of the primary and secondary of a wound-rotor induction motor in a single unit, the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., has developed the class 12-600 control panel illustrated. They are used with motors driving pumps, fans, cement mills and similar applications where the infrequency of operation makes manual control desirable.



Manual-type starter and speed regulator

The motor is started by closing the primary oil circuit breaker with all the resistance in the secondary circuit. The secondary drum is then gradually rotated through its successive contact positions, allowing the motor to accelerate. The motor is stopped by returning the drum to the "off" position, by tripping the primary breaker or by the use of a stop push-button station in series with the under-voltage trip of the primary breaker.

An electric lockout device is furnished that prevents starting the motor unless all the secondary resistance is in.

NEWS of the FIELD

Construction Work Progresses Rapidly on Safe Harbor Hydro-Electric Project

AT SAFE HARBOR, PA., on the Susquehanna River, about seventeen miles above the Pennsylvania and Maryland State line, rapid progress is being made on the hydro-electric development of the Safe Harbor Water-Power Corporation. This project will have an initial capacity of 255,000 hp., but the plant is so designed that it may be extended to 510,000 hp. Six units are on order and space is provided for six additional machines. The wheels are of the Kaplan type, having the blades adjusted automatically by the governor as the load changes. These wheels are rated at 42,500 hp. and the initial head is 53 ft. but will be 55 ft. ultimately. The runners for these units are the largest of their type so far used in America, being 220 in. in diameter, and will discharge 8,000 cu.ft. per second at rated power and speed. Three of the wheels are being built by the I. P. Morris & De La Vergne, Inc., and three by the S. Morgan Smith Company.

Power will be generated at 13,800 volts, 3-phase, and stepped up through transformer banks to 220,000 volts. Two single-circuit transmission lines will connect the plant with the Pennsylvania Water & Power Company's system and with the city of Baltimore.

A drawing of the completed structure is shown in the figure. Beginning at the left, which is the west bank, the west bulkhead will be 570 ft. long. The west spillway will be 1,356 ft. long with 24 Stoney type gates having a clean span of 48 ft. and will have ultimately 32 ft. of water above the sill. In the center of the river is an island, on which a bulkhead section of the dam 1,356 ft. long is being built. East of the island bulkhead will be a spillway section 454 ft. long with 4 Stoney type gates like those previously mentioned, and 4 double-leaf gates for regulating. A connecting bulkhead will be 58 ft. long. The power house, including the intake section for future units, will be 890 ft. long and the east bulkhead will be 300 ft. in length. These parts comprise a structure 4,984 ft. long.

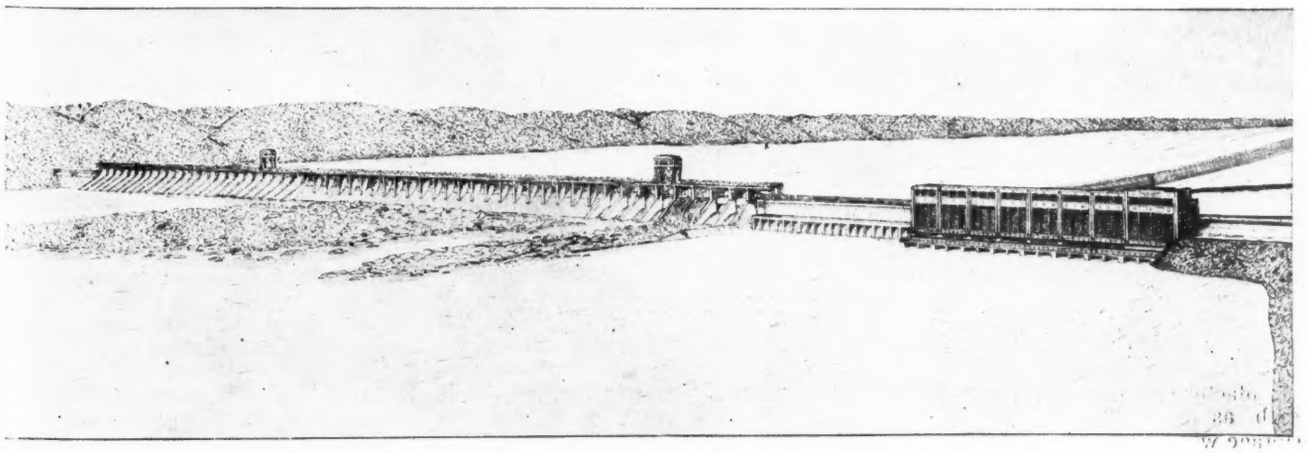
With the exception that the upper leaf of the four regulating gates will be lowered by remote-controlled hoists, located in the tunnels inside the dam, the gates will be raised by either of the two 150-ton gantry cranes. The discharge capacity of the spillways alone will be 970,000 cu.ft. per second with the pond at the initial normal elevation. Above the plant is a rock-filled breakwater connected to power house by a skimmer wall 1,495 ft. long.

At present, concrete work on the island bulkhead section of the dam is rapidly nearing completion. Excavation for the power house is well under way. The breakwater is completed and the skimmer wall is under construction. Present plans call for the plant to go into operation in 1932. The construction work is being done by the Arundel Corporation as contractors. The work includes placing 450,000 cu.yd. of concrete 13,000 tons of structure steel and 4,500 tons of reinforcing steel. A total rock excavation in the river of 640,000 cu.yd. will be made. For raising 8.6 miles of railroad track and building the breakwater 1,250,000 cu.yd. of loose rock will be required.

San Francisco to Confer on Hetch Hetchy Project

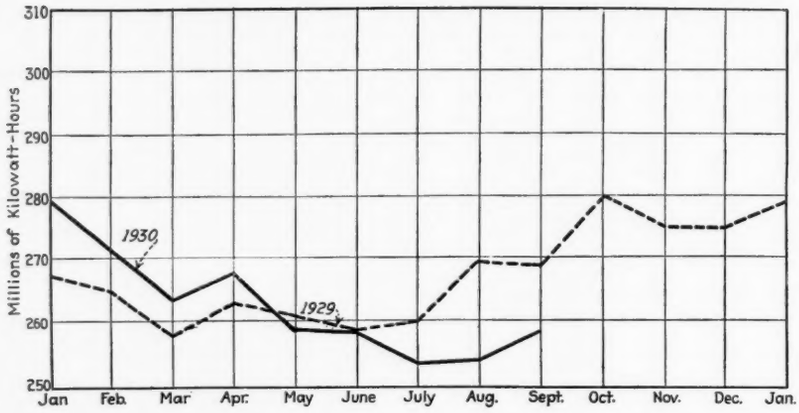
It has been announced at the Department of the Interior that a conference will be held on Nov. 26 at the request of the City of San Francisco to discuss the city's program for compliance with the Raker Act, under which the city's water and power development of Hetch Hetchy Valley in Yosemite National Park was permitted. That act requires the city to acquire and operate its own power distributing system; but recently a bond election which would have authorized issuance of bonds to purchase privately owned distributing systems failed.

As a temporary measure, the city, during the several years that have intervened between the building of its Hetch Hetchy Reservoir and the completion of the appraisal of private distribution systems, has avoided a large annual loss of power revenue by disposing of this Hetch Hetchy power under an agency contract with the Pacific Gas & Electric Company. The city will be asked to outline its future program for compliance with the Raker Act with respect to this power output.



Artist's sketch of the Safe Harbor water-power development as it will look when completed

Utility Power Production on Uptrend



AVERAGE DAILY PRODUCTION of electricity by public-utility power plants in the United States in September was 258,800,000 kw.-hr., 2 per cent more than the daily production in August, according to figures just issued by the Geological Survey of the Department of the Interior. This is the normal rate of increase in daily output from August to September. The daily output of electricity by the use of water power in September was 6 per cent less than in August. The normal decrease is 7 per cent. The total output of electricity by public-utility power plants in September of this year was 3.7 per cent less than for September of last year; the output for August of this year was 5.7 per cent less than for August a year ago. These comparisons evidently indicate that the continuing decrease in the demand for electricity has about ceased and that the demand is reacting normally to the usual seasonal activities.

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New Boiler Plant for Milwaukee Company

Federal Pressed Steel Corporation of Milwaukee, Wis., plans the construction of a new boiler plant to consist of two 6,000-sq.ft. watertube boilers equipped with underfeed stokers. Provision will also be made for the installation of a complete system of coal handling including an overhead type bunker. The boilers will operate at 250 lb. pressure.

The existing plans call for the supply of heating and process steam to at least one, if not two, neighboring manufacturing plants. Consideration is also being given to the feasibility of installing sometime in the near future a turbine-generator to supply all or part of the electric power requirements. Ottomar H. Henschel, consulting engineer of Milwaukee, is handling the plans for the plant.

Refrigeration Safety Code Approved by A.S.A.

A national safety code for mechanical refrigerators of all types, both domestic and commercial, has just been approved by the American Standards Association. Refrigerating apparatus used in the manufacture and processing of materials such as in ice-making plants, cold-storage warehouses, ice cream and dairy plants, packing houses, and chemical plants, and also cooling systems of theaters and other buildings are covered in the provisions of the code, which was prepared by a technical committee of the A.S.A. working under the direction of the American Society of Refrigerating Engineers.

The code applies both to direct methods of refrigeration, in which the refrigerant is circulated through the system, and to the indirect, in which brine or water cooled by the refrigerant is circulated through the system. Copies may be purchased from the A.S.A., 29 West 39th St., New York City, or from the A.S.R.E., 37 West 39th St., New York City, at 30 cents each.

Butte and Anaconda Vote Natural-Gas Franchise

Applications of the Montana Power Company for franchise to distribute natural gas in the cities of Butte, and Anaconda, Mont., were granted at recent elections held in the two cities. The Butte election, on Oct. 28, resulted in a majority of nearly seven to one; 2,767 votes were cast for the franchise, and 409 against the franchise. The election in Anaconda, Oct. 29, resulted in 876 for the franchise and 177 opposed.

According to the plan announced by Frank M. Kerr, vice-president and general manager, the company will construct pipe lines to bring natural gas 250 miles across the mountains from the Montana gas fields to Butte and Anaconda at an approximate expenditure of from $12,000,000 to $15,000,000. Approximately $2,000,000 will be spent for distribution systems in Butte and Anaconda. In the granting of the franchise in the two cities, the company has obtained the approval of two of the largest fuel-consuming centers in Montana.

There are two other elections involving gas pipe line franchises of the Montana company. Bozeman voted on Nov. 11 and Livingston on Nov. 14. These two cities are on the route of the proposed line, along which the company is seeking the support of communities in order to embrace as large a field of consumers as possible.

A.S.R.E. to Hold Meeting in New York, Dec. 3-6

Program has just been announced for the 26th annual meeting of the American Society of Refrigerating Engineers, to be held at the New Yorker Hotel in New York City on Dec. 3 to 6. Manufacturing carbon dioxide ice, quick freezing, humidity of cold storage, the application of A.S.R.E. and New York codes, frozen brines and ozone are among the subjects to be covered by experts in each field and discussed by members of the society at large.

Papers to be presented at the various sessions include: "Oil Refinery Refrigeration," by J. M. Wadsworth; "Frozen Brines," by R. C. Jessup; "Humidity of Cold Storage," by Milton W. Browne; "Manufacturing Carbon Dioxide Ice," by C. O. Duevel, Jr.; "The Young Engineer in Modern Industry," by A. R. Stevenson; "The Intermittent Absorption Machine," by D. F. Keith; "The Enclosed Motor Compressor, Patent Situation," by H. R. Van Deventer; "Basis of Commercial Machine Test Code," by John Wyllie, Jr.; "Noiseless Refrigeration," by C. H. Tanger, and "The Effect of Humidity on Heat Transmission in Galvanized Pipes," by W. R. Woolrich.

New Spier Falls Unit Placed in Operation

Power resources of the New York Power & Light Corporation were increased by 57,000 hp. on Nov. 5, when a new generator at the Spier Falls hydro-electric plant started on its operating career one month ahead of schedule. The addition of this machine will give Spier Falls a capacity of 100,000 hp., making it the largest hydro-electric station in the state with the exception of the Schoellkopf station at Niagara Falls. Its completion gives the Niagara-Hudson system a capacity of nearly 2,000,000 hp. The waterwheel is 20 ft. in diameter and during the low-water period will take the entire flow of the Hudson River.

A.S.M.E. and A.S.T.M. Plan High-Temp. Symposium

A symposium on the effect of temperature on the properties of metals is being planned for the annual meeting at Chicago in June, 1931, of the American Society for Testing Materials, by the joint high-temperature committee of the American Society of Mechanical Engineers and the A.S.T.M. The symposium will comprise two sessions, one on the trends in the engineering requirements for metals at high and low temperatures, and the other on the properties of available materials for high- and low-temperature service. The first session will cover trends in the power plant, oil, chemical, metal, automotive and ceramics industries, while the second session will cover fifteen distinct groups of metals or alloys now in use.

At both sessions the papers dealing with individual topics will not merely reflect the opinions of the author but will represent a cross-section of all he can find out on his subject from all sources. Early announcement is given the symposium, according to the committee, to stimulate those who may have facts, opinions, queries or points of view to offer on the various topics. All such should communicate as soon as possible with the joint committee.

Municipal Power for Salem

By a vote of nearly four and a half to one, the citizens of Salem, Ore., instructed the city council to proceed with steps necessary to the acquisition of water from Marion Lake for municipal power purposes. The question had been placed on the ballot by resolution of the city council.

Barber Selected to Make Washington Power Survey

Earl H. Barber, consulting engineer of Reading, Mass., has been appointed to make a survey of the power needs of the District of Columbia for which Congress appropriated $25,000 last July with a view to establishing a municipally-owned and operated service. The language of the law appropriating the fund is rather broad but has been construed by the Board of Commissioners of the District of Columbia to refer only to the power requirements of the district government as distinguished from commercial and household requirements. The study will be confined, therefore, to requirements for public buildings, street lighting and other publicly-owned facilities.

Mr. Barber has been intimately identified with the regulation, financing and operation of public utilities in Massachusetts for the past 15 years and at present is adviser to the Commission of the Department of Public Utilities of that state. There are 44 municipal plants, 56 electric companies and 51 gas companies in the state, and Mr. Barber reports that since 1927 he has been working directly with them, particularly the municipal undertakings over which the state commission has practically no control, on problems of rates and management. He has assisted them, he says, in modernizing their rate schedules and bringing their rates down to the conspicuously low level they have attained. He also simplified the calculation of street lighting rates.

Muscle Shoals Committee to Meet on December 2

Senator McNary of Oregon, chairman of the Senate Committee on Muscle Shoals Legislation, announced Nov. 10 that he would call a meeting of the committee Dec. 2 to seek a solution to the problem.

The committee has been in deadlock since late in the last session of Congress over two conflicting bills, one introduced by Senator Norris of Nebraska, providing for government operation, the other introduced by Representative Reece of Johnson City, Tenn., providing for leasing this property to private interests.

Senator McNary stated that he would advocate an acceptance of the Norris bill by the committee. "So far as I am concerned, and I believe the majority of the Senate agrees with me, I propose to follow the principles of the Norris bill which is for government development," he said.

News of Canada

Pend Orielle plans filed — White Mud Falls may be developed sooner than expected — Brandon to have provincial service

PLANS filed by the West Kootenay Power & Light Company with British Columbia provincial authorities for the development of the Pend Oreille River, show that it will be easily the largest single unit power scheme in British Columbia, and one of the largest in Canada. The dam will be 365 ft. in height from the river bottom, by far the highest in Canada. Plans provide for the development of 175,000 hp. In addition to this the company is developing 162,000 hp. by its three plants on the Kootenay River and a new plant to produce 30,000 hp. from the Kootenay River is now under construction. Original schemes for the Pend Oreille development called for two dams, but subsequent borings have proved the one gigantic dam feasible. It will produce a flow of 6,000 cu.ft. per second, which is sufficient to develop 175,200 hp., but if a greater flow can be obtained it will be possible to increase this output commensurately.

THE GREAT POWER DEVELOPMENT to be undertaken by British interests at White Mud Falls, on the Nelson River, in the province of Manitoba, may come sooner than expected, according to information now available. This development would be of outstanding importance to Northern

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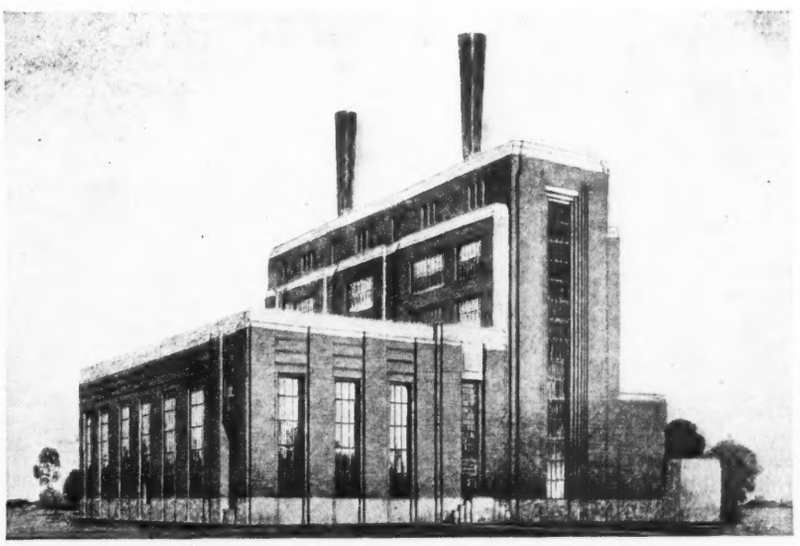
MODERNISTIC POWER PLANT



The influence of modern art is apparent in this architect's sketch of the Virginia Public Service Company's new steam-electric generating station at Bremo Bluff, Va., which is scheduled to go into operation on Jan. 1. It will have an initial installed capacity of 40,000 hp. which later will be increased to 134,000 hp., and ultimately to 267,000 hp.

Manitoba through the provision of low-cost electric energy for the various mining fields not now served.

A priority permit for this development was given to the British Dominion Power Company of Canada in 1928, and the permit was renewed for another year last May. The company now has offices in Winnipeg. During the past few months the company, headed by Sir Reginald Brade, and represented in Manitoba by Capt. R. Morrison, has been working steadily on the preliminaries looking to the development of White Mud Falls. The problem has been approached cautiously, as the program did not contemplate any abnormal effort toward speed, but conditions have very recently arisen which officials of the company believe to justify a different line of action. The chief factor in this connection is the fact that Winnipeg appears to be faced with a power shortage. It is now contended that the development of White Mud Falls would alleviate this condition, and it is considered feasible to plan on the transmission of power from White Mud to the Manitoba capital.

THE CITY OF BRANDON, Manitoba, is to have provincial hydro-electric service. It will be connected to the great hydro-electric generating stations on the Winnipeg River as a result of the decision of the Manitoba Government to take over for the provincial hydro the power plant, equipment and distribution system of the Canada Gas & Electric Corporation now serving Brandon. The Manitoba Power Commission is to take possession of the Brandon plant on Jan. 1, and electrical energy from the provincial distribution system will then be supplied over the new steel tower transmission line that has recently been completed from Portage la Prairie.

How's Business?

WITH BUSINESS OPINION obviously content to throw away the last two months of this year, there is nothing surprising in the continued decline of general business activity to lower levels week after week as the period of even normal seasonal stimulus passes. Our preliminary index for the week ended Nov. 8 fell further, from 81.5% of normal to 79.3%, and is evidently still feeling for the bottom in waters never before tested but probably deeper than any heretofore sounded in past depressions. Declining industrial activity is pulling it down more than general trade, and this fact lends some support to the hope that the lower it goes the sooner it will turn up.—*The Business Week*, Nov. 19.

COMING CONVENTIONS

American Society of Mechanical Engineers. Annual meeting in New York City, Dec. 1-5. National Fuels Meeting in Chicago, Ill., Feb. 10-13, 1931. Secretary, Calvin Rice, 33 West 39th St., New York City.

American Institute of Electrical Engineers. District meeting at Louisville, Ky., Nov. 19-22. Annual Winter convention in New York City, Jan. 26-30, 1931. Secretary, F. L. Hutchinson, 33 West 39th St., New York City.

American Society of Heating and Ventilating Engineers. Annual meeting at the William Penn Hotel, Pittsburgh, Pa., Jan. 26-29, 1931. Secretary, A. V. Hutchinson, 51 Madison Ave., New York City.

American Society of Refrigerating Engineers. Annual meeting at the Hotel New Yorker, New York City, Dec. 3-6. Secretary, David L. Fiske, 37 West 39th St., New York City.

International Acetylene Association. Annual convention at the Congress Hotel, Chicago, Ill., Nov. 12-14. Secretary, A. C. Morrison, 30 East 42nd St., New York City.

Midwest Power Engineering Conference and Exposition. Fifth meeting in Chicago, Ill., Feb. 10-13, 1931. Secretary, George E. Pfisterer, 308 West Washington St., Chicago, Ill.

National Power Show. Grand Central Palace, New York City, Dec. 1-6. Manager, Charles F. Roth, Grand Central Palace, New York City.

Obituary

WILLIAM PIEZ, European correspondent of the Link-Belt Company, and a brother of Charles Piez, chairman of the board of the company, died at Brussels, Belgium, on Nov. 2 after a week's illness. Mr. Piez, previous to his association with the Link-Belt Company, was district manager of the Concrete Steel Company of Chicago. Since 1928 he had lived at Paris, France, where he functioned as European correspondent of the Company. He was born at Newark, N. J., in 1878.

ARTHUR W. THOMPSON, former president of the Philadelphia Company of Pittsburgh, Pa., and the United Gas Improvement Company of Philadelphia, Pa., died Nov. 9 in West Pennsylvania Hospital at Pittsburgh, of an acute infection of the heart. Born at Erie, Pa., on May 8, 1875, Mr. Thompson was a graduate of Allegheny College in civil engineering. For many years he was engaged in railroad work, until in 1919 he entered the utility field as president of the Philadelphia. Later he became head of the U.G.I. company, resigning from both positions in January, 1929. Since that time he had been engaged in consulting engineering with offices in Philadelphia.

Personals

H. L. GUY, chief engineer of the mechanical department of the Metropolitan Vickers Electrical Company, Ltd., of Manchester, England, has just returned to London after a month's visit in this country for the purpose of investigating American steam power plant practice. Mr. Guy is a prominent member of the International Steam Tables Committee, a member of the council of the British Institution of Mechanical Engineers and a member of the International Electrotechnical Commission.

PROF. DONALD B. PRENTICE, dean of Lafayette College and head of its department of mechanical engineering, has recently been appointed president of Rose Polytechnic Institute at Terre Haute, Ind. Professor Prentice will take up his new duties on Feb. 1, 1931.

FRANCIS L. SEARWAY has joined the Stone & Webster Engineering Corporation, Boston office, as engineer in the appraisal division. Previous to this connection Mr. Searway was associated as appraisal engineer with the Shell Eastern Petroleum Products Company; Forstall, Robinson & Luqueer, and Lockwood, Greene & Company.

THOMAS R. WEYMOUTH has resigned as chairman of the board of the Oklahoma Natural Gas Corporation to become vice-president of the Columbia Engineering & Management Corporation of New York City. Mr. Weymouth was recently elected a vice-president of the American Society of Mechanical Engineers.

ROBERT CRAMER, formerly chief engineer and recently appointed consultant of the Sewerage Commission of the City of Milwaukee, Wis., has opened a consulting engineering office in that city, specializing in sewage-disposal plants and systems; power plant design, construction and operation; utilization and disposal of industrial wastes; laboratory service; valuation, and reports.

STUART F. KOSTER, for the past eleven and a half years with Swift & Company interests in St. Joseph, Mo., has joined the Stone & Webster Engineering Corporation as engineer in the appraisal division. He will be located at the corporation's Boston office.

BRINTON WELSER, secretary of the Chain Belt Company of Milwaukee, Wis., has been elected vice-president and director of the company. Mr. Welser has been with the Chain Belt Company since 1913 and is widely acquainted throughout the industry. He will continue his activities in engineering and sales work.

EARLE S. HENNINGSEN has been appointed engineer of the alternating-current engineering department of the General Electric Company, to succeed H. G. Reist, who has retired.

Business Notes

PEABODY ENGINEERING CORPORATION, New York City, announces that it has declared a special dividend of $15 a share payable immediately to holders of the common stock of the company, and that it has established a fund not to exceed $7 a share of the common stock to be distributed at once among the employees of the company in lieu of the bonus and profit sharing usually made payable during the Christmas holidays. This action was taken, according to E. H. Peabody, president of the corporation, as a contribution to the efforts being made in various quarters to hasten the return to normal business conditions.

THE BIGELOW COMPANY, New Haven, Conn., announces the appointment of W. S. Anderson, Jr., as sales engineer in charge of the Boston office.

THEW SHOVEL COMPANY and UNIVERSAL CRANE COMPANY announce the removal of their Atlanta sales offices to 1513-14 William Oliver Building, Five Points, Atlanta, Ga.

CLEMENTS MANUFACTURING COMPANY, Chicago, Ill., is erecting a new factory at 66th Place and South Narragansett Avenue, in the heart of the clearing industrial district of Chicago. This new plant will occupy an area of 24,000 sq.ft. of land with 21,000 sq.ft. of factory floor space, and will be of the monitor type construction. It is scheduled to be finished by Feb. 1, 1931.

HARBISON - WALKER REFRACTORIES COMPANY, Pittsburgh, Pa., announces the completion of a 5,000-ft. motion picture illustrating modern methods employed in the manufacture of refractories. The film shows every step in the production of refractories from the mining of raw materials to the loading and shipping of the finished product. Scenes in the research and control laboratories and some interesting animated photography showing the action of periodic and continuous tunnel kilns are also included in the picture. It is available, without cost, to technical societies, engineering organizations, industrial organizations, universities, colleges, technical schools and research laboratories.

CHAIN BELT COMPANY, Milwaukee, Wis., announces the following changes in executive personnel: C. F. Messinger, vice-president of the company, has been elected general manager; H. S. Greene, formerly general sales manager of the Barber-Greene Company of Aurora, Ill., who joined the Chain Belt Company in 1929, succeeds Mr. Messinger as general sales manager; Brinton Welser, formerly secretary, has been elected director and vice-president; J. C. Merwin was re-elected vice-president; A. R. Abelt was elected secretary of the company, and continues in charge of chain sales; W. H. Brandt, formerly assistant secretary, becomes assistant to the president.

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With the SOCIETY SECTIONS

A.I.E.E., Boston Section. Meeting at the Walker Memorial Building, M.I.T., on Nov. 18 at 6:30 p.m. Subject: "Louisiana Power Station of Louisiana Steam Products, Inc.," by J. F. McLaughlin of Louisiana Steam Products, Inc., and C. R. Stewart, W. L. Locke and H. J. Klotz of Stone & Webster.

A.S.M.E., Buffalo Section. Afternoon meeting at the Red Coach Inn, Niagara Falls, N. Y., on Nov. 22 at 2 p.m. Inspection trip through Niagara Falls Power Company Plant, followed by talk on "Separation Problems in the Process Industries," by E. M. James of the Sharples Specialty Company.

A.S.M.E., Worcester Section. Meeting at the Aurora Hotel on Nov. 19 at 6 p.m. Subject: "Generation of Power by Steam," by Elmer Smith, turbine specialist of the General Electric Company.

A.I. & S.E.E., Philadelphia Section. Meeting at the Engineers' Club on Dec. 6 at 7 p.m. Subject: "The Influence of Modern Electrical Equipment Design on Brush Performance," by William Siebenmorgen of Electro Service, Inc.

A.W.S., New York Section. Meeting at the Engineering Societies Building on Nov. 18 at 7:45 p.m. Symposium on "Present Status of Structural Welding Throughout the United States From the Standpoint of Application and Regulation."

Plant Engineers' Club, Boston. Meeting at the University Club on Nov. 19 at 7:30 p.m. Subject: "Modern Steam Generation," by J. H. Rohrer of the Badenhausen Corporation.

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Trade Catalogs

CRANES—Under the title "Crane Engineering," the Whiting Corporation of Harvey, Ill., has just published a 160-page flexibly bound handbook of crane information compiled by M. F. Beetham, crane engineer. This is believed to be the first handbook in this highly important field and contains complete data on the selection, installation and maintenance of cranes, together with many engineering charts and tables. It is fully illustrated by line cuts and half tones. Copies may be obtained from the company at $2 each.

STOKERS — Catalog E-7 illustrating and describing Type E center-retort underfeed stokers for burning either coking or non-coking bituminous coals and various refuse fuels in installations ranging from 150 to 600 hp., Combustion Engineering Corporation, 200 Madison Ave., New York City.

PROTECTIVE COATINGS—Bulletin 1238 illustrating and describing the use of Apexior coatings for the prevention of corrosion in power plant equipment, Dampney Company of America, Hyde Park, Boston, Mass.

DIESEL ENGINES—Illustrated 79-page bulletin on "The Modern Trend in Merchant Ships," a reprint of Edward B. Pollister's address before the Tenth Annual Middle West Foreign Trade and Merchant Marine Conference at Indianapolis, Oct. 28, Busch-Sulzer Bros.-Diesel Engine Company, 2nd and Utah Sts., St. Louis, Mo.

ELECTRICAL PRODUCTS—The general catalog for 1931-32, comprising 1,352 pages of illustrated description, has just been issued by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa. Listings are given of distribution apparatus, switchgear, gearing apparatus, current-collecting devices, industrial motors, control apparatus, lighting equipment and a host of other electrical products.

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Fuel Prices

FUEL OIL

New York—Nov. 13, f.o.b. Bayonne, N. J., 28@34 deg., Baumé, industrial use, tank-car lots, 4.5c. per gal.; f.o.b. Bayway, 36@40 deg., furnace, tank-car lots, 6c. per gal.

St. Louis—Nov. 4, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.345 per bbl., or 42 gal.; 26@28 deg., $1.47 per bbl.; 28@30 deg., $1.595 per bbl.; 30@32 deg., $1.695 per bbl.; 32@36 deg., gas oil, 4.026c. per gal.; 38@40 deg., distillate, 4.651c. per gal.

Pittsburgh—Nov. 4, f.o.b. local refinery, 34@36 deg., fuel oil, 3.87½c.@4c. per gal.; 36@40 deg., 3.75c.@4c.

Philadelphia — Nov. 9, 13@19 deg., $1.05@$1.10 per bbl. or 42 gal.; 18 deg. plus, $1.475@$1.525 per bbl.; 23@27 deg., $2.00@$2.05 per bbl.

Cincinnati — Nov. 11, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5.25c. per gal.; 26@30 deg., 5.5c. per gal.; 30@32 deg., 5.75c. per gal.

Chicago—Nov. 4, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl. or 42 gal.; 22@26 deg., 70c. per bbl.; 26@30 deg., 90c.@95c. per bbl.; 30@32 deg., $1.05 per bbl.

Boston—Nov. 10, tank-car lots, f.o.b. 12@14 deg., Baumé, 2.9c. per gal.; 28@32 deg., 4.85c. per gal.

Dallas—Nov. 8, f.o.b. local refinery 26@30 deg., $1.10 per bbl. or 42 gallons.

COAL

Bituminous (Net Tons)	At Mine, for Shipment to	Price per Ton
Pool 9, super low-vol.	New York	$1.75 @ $2.00
Pool 10, hr.gr. low-vol.	New York	1.60 @ 1.75
Pool 11, low-vol.	New York	1.40 @ 1.60
Smokeless, mine-run	Chicago	1.75 @ 2.25
Smokeless, slack	Chicago	.50 @ 1.50
Harlan, Ky., slack	Chicago	.50 @ .90
Franklin, Ill., mine-run	Chicago	2.15
Franklin, Ill., screen	Chicago	1.20 @ 1.60
Ind. 5th Vein, m.-r.	Chicago	1.50 @ 1.85
Standard Ill., mine-run	St. Louis	1.50
W. Ky., mine-run	Louisville	1.00 @ 1.25
W. Ky., slack	Louisville	.25 @ .50
Pittsburgh, mine-run	Pittsburgh	1.30 @ 1.60
Smokeless, mine-run	Cincinnati	2.00 @ 2.25
Smokeless, slack	Cincinnati	1.00 @ 1.35
Kanawha, mine-run	Cincinnati	1.10 @ 1.35
Kanawha, nut-slack	Cincinnati	.40 @ .65
Anthracite (Gross Tons)	At Mine, for Shipment to	Price per Ton
Buckwheat	New York	$3.00@$3.15
Barley	New York	1.15@ 1.50

New Plant Construction

COMPILED BY THE McGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Ariz., Phoenix — City plans extensions and improvements to waterworks system including pumping units, distribution lines, etc. Estimated cost $2,925,000. W. J. Jamieson is city engineer.

Calif., Los Angeles—City defeated election of Nov. 4, for $13,300,000 bonds to augment and improve power facilities at Owens Valley water and power system, also survey and acquisition of power transmission line from Boulder dam to Los Angeles.

Ia., Grundy Center—City plans an election Nov. 17 to vote $80,000 bonds for the construction of a light and power plant. J. W. Wiersma is engineer.

Mass., Boston — Institutions Dept., awarded contract for boiler equipment at Long Island Hospital to J. J. Hurley & Co., 104 Broadway, $32,688.

Mass., Framingham — Town, A. C. Winch, Chn. Bd. of Pub. Works, awarded contract for the construction of a pumping station and equipment at Reservoir No. 1 on Winter St. to T. A. Sheehan, 403 Union Ave.

Mich., Detroit—Public Lighting Commission, Atwater St., awarded contract for the construction of Woodward Terminal and Philip Ave. electric sub-stations, to H. G. Christman Burke Co., Fisher Bldg., $81,900.

Minn., Blooming Prairie—City awarded contract for the construction of a municipal light, heat and power plant to N. Wagner, Austin; Diesel engine and generating equipment to Fairbanks-Morse & Co., Park Sq., St. Paul, and electric distribution system to Keller Electric Co., 1138 Main St., Dubuque, Ia. Estimated total cost $64,958.

Minn., McGregor—General Minnesota Utilities Co., Pine City, plans the construction of a power plant here. Estimated cost $80,000.

N. J., Hackensack—Bd. of Chosen Freeholders, J. M. Harkness, Clk., Court House, is having plans prepared for the construction of a 6 story administration building including steam heating and ventilation systems, boilers, elevators, etc. at Main and Hudson Sts. Estimated cost $1,200,000. E. L. Tilton and W. F. Schwanewede, 420 Lexington Ave., New York, N. Y., are architects.

N. J., Jersey City — Bd. of Commissioners, City Hall, awarded contract for the construction of a 3 story addition to power house and laundry at Baldwin and Montgomery Sts. to Auf Der Heide Contracting Co., 443 16th St., West New York. Estimated cost $800,000.

N. J., Paterson—Bd. of Chosen Freeholders, Court House, is having revised plans prepared for the construction of a 20 story county detention jail and hall of records building including steam heating system, etc. at Spring and Jackson Sts. Estimated cost $3,500,000. H. B. Crosby, First National Bank Bldg., is architect.

O., Cleveland — Bd. of Education, F. G. Hogen, Dir., received lowest bid for the construction of a 3 story, 224 x 416 ft. high school, including steam heating system, etc., at West 140th St. and Dakota Ave., from Crowell & Little Construction Co., Hanna Bldg. Estimated cost $800,000.

Okla., Cleveland—City is having plans prepared for the construction of a municipal electric light plant. Estimated cost $75,000. Private plans.

Okla., Cushing—City plans an election Dec. 2 to vote $300,000 bonds for the construction of a 2,500 hp. Diesel engine electric light plant. G. Estey, is engineer.

Okla., Nowata — City is having plans prepared for the construction of a municipal electric light plant. Estimated cost $100,000. Engineer not announced.

Okla., Vinita — City is having preliminary surveys made for the construction of a municipal light and power plant and distribution system, etc. also natural gas distribution system. Estimated cost $240,000 and $125,000 respectively. Russell & Axon, 6200 Easton Ave., St. Louis, Mo., are engineers.

Pa., Pittsburgh—City, E. G. Lang, Dir. of Public Works, City County Bldg., will receive bids until Nov. 28 for foundations for new pumping station. Estimated cost $285,000. C. M. Reppert, City County Bldg., is engineer.

Pa., Pittsburgh—Duquesne Light Co., 435 6th Ave., awarded contract for the construction of a sub-station at Main and Homley Sts. to Byllesby Engineering & Management Corp., 435 6th Ave.

Pa., Tarentum — Boro of Tarentum, J. F. Conroy, Secy., 304 Lock St., received lowest bids for a 1 story, 30 x 100 ft. addition to electric light and water plant from Pitt Construction Co., Starr Bldg., Pittsburgh, $29,327.

Tex., Dallas—Dallas Gas Co., 2016 Jackson St., awarded contract for the construction of a 13 story office building at Jackson and Harwood Sts., to Joplin Construction Co., Fidelity Union Bldg. Estimated cost $1,000,000. Steam heating system, etc., will be installed.

Tex., Dallas—Dallas Power & Light Co., Interurban Bldg., has work under way on the construction of spillway and earthen dam 8,600 ft. long 225 ft. wide at base and 16 ft. wide at crown at Mountain Creek near here. $1.-500,000 W. E. Callahan Construction Co., under way for first unit of power plant initial capacity 35,000 kw., ultimate capacity 120,000 kw. Initial cost $3,000,000.

Tex., Kerrville—U. S. Veteran's Bureau, War Dept., Washington, D. C., plans the construction of a 15 story sanitorium including steam heating, ventilation and refrigeration systems, boiler pump, elevators, swimming pool, etc., here. Estimated cost $1,800,000. Livesay & Wiedemann, San Jacinto Life Bldg., Beaumont, are architects.

Utah, American Fork — State Building Commission, will soon award contract for the construction of state training school for delinquent boys, including dormitories, service hall, administration building, heating plant, etc. Estimataed cost $150,000. Scott & Welch, Dooly Bldg., Salt Lake City, are architects. R. K. Brown, c/o Utah State Building Commission, Salt Lake City, is engineer.

Utah, Mount Pleasant—City voted $40,000 bonds for the construction of a municipal hydro-electric plant. Estimated cost $40,000. Caldwell & Richards, Templeton Bldg., Salt Lake City, are engineers.

Wash., Seattle—Bureau of Yards & Docks, Navy Dept., will receive bids until Dec. 3 for the construction of a boiler plant.

Wis., Milwaukee—Terminal Warehouse Co., 106 West Seeboth St., awarded contract for pile driving for a 5 story cold storage warehouse to E. E. Gillen, East Water St.

Alta., Lethbridge—City awarded contract for supply and installation of two 500 hp. boilers, super-heaters and economizers for municipal power plant to Electric Power Equipment Ltd., Vancouver, B. C.

Ont., Lindsay—City is having plans prepared for the construction of a sewage disposal plant including pumping station, etc. F. A. Dallyn, 71 King St. W., Toronto, is engineer.

Ont., Nepeau Township—R. E. Nelson, will soon receive bids for the construction of a pumping station. Estimated cost $75,000.

Ont., Toronto — Bank of Nova Scotia, 39 King St. W., awarded contract for the construction of an office building at Bay and King Sts., to George A. Fuller Co. of Canada Ltd., McLean Bldg. Estimated cost $5,000,000. Steam heating system, elevators, etc., will be installed.

Equipment Wanted

Control Apparatus—Pittsburgh, Pa.—City, E. G. Lang, Dir. of Public Works, City County Bldg., will receive bids until Dec. 5 for control apparatus and connections for six synchronous motors and appurtenances and complete lighting installation for Brilliant pumping station. Estimated cost $90,000.

Electric Motors and Boiler—Montreal, Que.—Canadian Benedict Stone Ltd., 6096 Lafontaine St., plans to purchase ten 187½ hp. electric motors and one 80 hp. steam boiler.

Engine—San Francisco, Calif.—Quartermaster Supply Officer, General Depot, Fort Mason, will receive bids until Nov. 28 for engine, steering, combined steam and hand driven 5 x 5½ in. Hyde (Schedule 928-31-120).

Engines, Generators, Exciters, etc.—Sikeston, Mo.—City will receive bids until Nov. 24 for two 600 hp. Diesel engines, generators, exciters and auxiliaries, 1,200 kw. switchboard, etc., for proposed municipal electric light and power plant.

Motor — Reading, Mass. — Porter-Milton Ice Co.—plans to purchase one 75 hp. 440 v. 3 ph. 60 cycle a.c.

Motor—Everett, Mass.—W. T. French, 25 Garvey St., plans to purchase a 5 hp. a.c. 3 ph., 550 v. electric motor.

Pump—Madera, Calif.—City Council, will receive bids until Dec. 1 for a sewage pump for disposal plant.

Pump—Columbia, Ill.—City plans to purchase a new pump, etc., for proposed waterworks imrovements.

Pumping Equipment — Westboro, Mass. — Dept. of Mental Diseases, State House, Boston, will receive bids until Nov. 21, for pumping equipment for Westboro State Hospital, here.

Pumping Equipment—Marble Falls, Tex.—B. C. Goeth, pumping equipment for proposed extensions and improvements to waterworks. Estimated cost $60,000.

Pumping Equipment—Erieau, Ont.—Harwich Township plans to purchase pumping equipment, etc. in connection with flood prevention and reclamation project. Estimated cost $100,000.

Pumps, etc.—Clinton, La.—Bd. of Aldermen, will receive bids until Nov. 24, for pumps, etc. for proposed waterworks system.

Pumps, etc.—Colborne, Ont.—Town plans to purchase pumps, etc., for proposed waterworks system. Estimated cost $65,000.

Pumps, Motors, etc. — Alexandria, Ont. — Town, will soon receive bids for pumps, motors, etc., for proposed waterworks system. Estimated cost $20,000.

Industrial Projects

Ill., Galesburg—Standard Oil Co. of Indiana, W. H. Caldwell, Mgr., plans the construction of a 1 story, 56 x 528 and 52 x 87 ft. distribution plant, including boiler room, barrel filling room, warehouse, etc., on Cherry St. Estimated cost $30,000.

N. Y., Hoosick Falls—Fuelite Natural Gas Co., Waltham, Mass., plans the construction of a new gas plant, here.

N. Y., Long Island City — General Bronze Corp., 34-19 10th Ave., plans unification of facilities to single plant. Estimated cost $500,000 to $1,000,000. Maturity in January.

N. Y., New York—Attica Film Corp., 1501 Broadway, awarded contract for a factory at 521-531 West 43rd St. Estimated cost $550,000.

N. Y., Port Ivory—Proctor & Gamble Co., 17 Battery Pl., New York, is receiving bids (time extended) for a 1 story addition to boiler house here. Estimated cost $40,000. Private plans.

N. Y., Schenectady — General Electric Co., (Refrigeration Division) River Rd., plans the construction of a refrigerator manufacturing plant. Estimated cost to exceed $40,000.

O., Cleveland — Acme Rayon Corp., P. S. Green, Pres., 1294 West 70th St., awarded contract for the construction of a 1 story addition to boiler house at 1294 West 70th St., to W. J. Pierik, 7016 Euclid Ave. Estimated cost $40,000.

Pa., Emlenton — Emlenton Refining Co., awarded contract for an oil cracking plant to Universal Oil Products Co., 310 South Michigan Ave., Chicago, Ill. $250,000. This is last unit of $1,000,000 program.

Tex., Baytown—Humble Oil & Refining Co., Humble Bldg., Houston, has work under way on the construction of a 74 x 175 ft. power plant, here. Estimated cost $110,000. Jackson & Moreland, 31 St. James Ave., Boston, Mass., are engineers. Work being done by day labor.

Tex., Fort Worth—Texas Ice & Refrigeration Co., 1201 Jones St., awarded contract for the construction of a 1 and 2 story produce market to T. S. Byrne, Fort Worth National Bank Bldg. Estimated cost $150,000.

Wash., Longview — Lower Columbia Dairy Association, Astoria, Ore., A. E. Engbretson, Secy. of Lower Columbia River Dairy Assoc., will receive bids about Jan. 1, for a creamery including refrigeration equipment, boilers, engines, pumps, etc., at 11th St. and California Way, here. Estimated cost $80,000.

Wis., Milwaukee—American Candy Co., 215 Broadway, plans to rehabilitate power plant, also manufacturing plant electric and mechanical equipment. O. H. Henschel, 401 Commerce Bldg., is consulting engineer.

Wis., Milwaukee—Federal Pressed Steel Corp., 50 Keefe Ave., is having plans prepared for the construction of a new power plant, initial installation will consist of stoker, fired high pressure boilers; ultimately electrical generating equipment will be added. O. H. Henschel, 401 Commerce Bldg., is consulting engineer.